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THE FEEDING HABITS OF CALIFORNIA GARTER SNAKES [1]

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INTRODUCTION

The garter snakes are among the most abundant and generally distributed of any California snakes, and hence are of considerable economic importance. Like any other common and widely distributed animal species, they necessarily have diverse ecologic interrelationships which cause them to affect man's varying interests both adversely and favorably. The several kinds differ from each other, greatly in some instances, in their feeding habits, so that each must be appraised separately in any study of economic status. The feeding habits have most direct bearing on man's interest. The present report is concerned with the feeding habits of the kinds of garter snakes which occur in California, except that one species, *Thamnophis marcianus,* is not included. No data concerning its feeding habits are available, and it is unimportant because of the limited area it inhabits within the State. Its California distribution originally was restricted to the Colorado River, but recently it has spread westward along irrigation canals into Imperial Valley. (Klauber, 1939, p. 22.)

Garter snakes are predatory in their habits and take small animals of many kinds. The prey includes only such animals as can be caught, overpowered, and swallowed whole. Most often the prey is swallowed alive; rarely it may be killed by constriction, as observed by the writer in the case of a mouse attacked by a captive individual. Garter snakes rely upon the sense of smell as well as upon sight to find their prey, and will usually eat any freshly killed animals of the kinds which comprise their natural foods. It is not known how much an individual snake normally eats under natural conditions. They are able to fast for periods of weeks or even months, but probably feed at intervals of a few days, or even oftener during warm weather when food is abundant. The food requirement varies according to temperature; in cold weather metabolism is slowed down so that but little food is required. During the three to six months of hibernation these snakes take no food.

Garter snakes are of especial interest as destroyers of fish. They occasionally attain great abundance along trout streams, and instances of garter snake predation on trout are known to many anglers. From the following account it will be evident that only certain kinds, which

[1] Submitted for publication, July, 1940. Published by permission of the U. S. Fish and Wildlife Service.

are easily recognizable, prey upon trout or other game fishes. Other kinds, just as abundant and widely distributed, seldom or never eat fish, but feed in whole or in part on animals which are generally considered harmful. In California the garter snakes are the only snakes which tend to be aquatic in habits, and the group includes all of the kinds popularly known as "water snakes" within the boundaries of this State.

The data herein presented are much too fragmentary to furnish a complete picture of the feeding habits of garter snakes in California. For some kinds only a few feeding records are available and these may not be typical. Probably an even greater variety of food is utilized than is indicated by the records here compiled. Nevertheless, these records extend throughout most of the ranges, being well scattered over a very large area and representing all seasons during which the snakes are active. They may, therefore, be expected to yield a fairly reliable idea of the kinds of food in general used by those kinds of California garter snakes which are common and widely distributed.

Acknowledgments

This study of the food habits was carried on in the field and at the University of California Museum of Vertebrate Zoology, and the writer is indebted to the late Dr. Joseph Grinnell, Director of the Museum, for help in many ways. The writer is, likewise, indebted to members of the Museum staff and to many of the graduate students in the Museum for cooperation and assistance in the pursuit of this study. Dr. Jean M. Linsdale and Mr. Thomas L. Rodgers are due especial thanks. Specimens used were borrowed from the California Academy of Sciences, the University of Michigan Museum of Zoology and the San Diego Society of Natural History. For use of these collections the writer wishes to thank Mr. Joseph R. Slevin, Dr. Helen T. Gaige and Mr. Laurence M. Klauber.

CLASSIFICATION AND DISTRIBUTION

The garter snakes are members of the family Colubridae, which includes the majority of nonpoisonous snakes, and of the cosmopolitan subfamily Natricinae, or water snake group, characterized by aquatic tendencies, keeled (ridged) scales, enlarged anal glands which produce a characteristically foul-smelling secretion (often serving to repel attacking predators) and simple, unbranched hemipenes (the paired copulatory organs of the males), which are set with rows of spines.

The genus *Thamnophis,* the garter snake group, is entirely North American and Central American in its range, occurring northward farther than any other reptiles in this hemisphere. All the garter snakes are, of course, nonpoisonous. Members of the genus in general tend to be aquatic in their habits. Most of them have a light dorsal stripe and two lateral stripes on a darker ground color. They differ from closely related water snakes (genus *Natrix*) in having the anal plate (the enlarged ventral scale just anterior to the anus) undivided. There are five major groups of garter snakes, each comprising a series of closely related species and subspecies. Only two of these major groups are represented in California; *Thamnophis sirtalis,* represent-

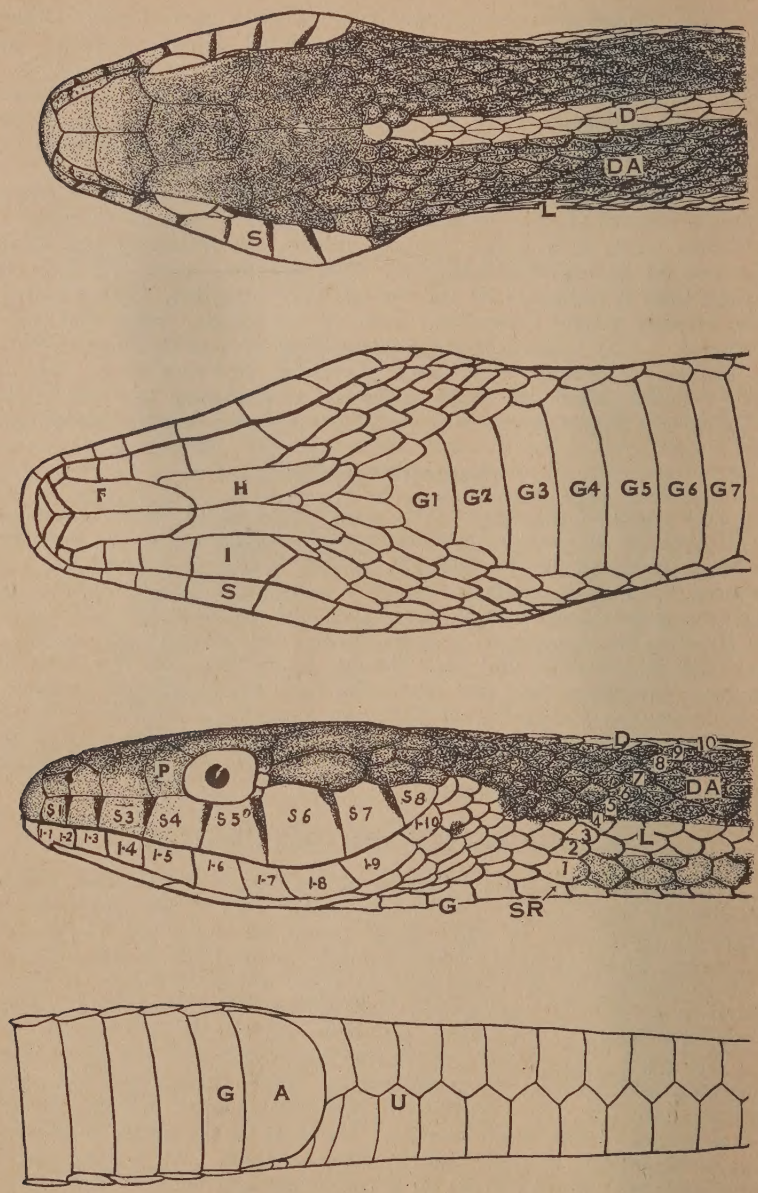


FIG. 22. Important structural features of a garter snake as seen from dorsal, ventral and lateral views of head, and ventral view at posterior end of body. A—anal plate; D—dorsal stripe; DA—dorsolateral area; F—anterior genial; G—gastrosteges, numbered to show method of counting; H—posterior genial; I—infralabials, numbered to show method of counting; L—lateral stripe; S—supralabials, numbered to show method of counting; SR—scale rows, numbered to show method of counting diagonally across body; U—urostege.

ing one group in California, occurs also throughout most of the United States. The *Thamnophis ordinoides* group is confined to the region west of the Great Plains, and attains its greatest abundance and diversification within the California fauna. The Californian forms *ordinoides, biscutatus, atratus, hydrophila, couchii, gigas, hammondii, elegans,* and *vagrans* are all members of this group.

Key to the Garter Snakes of California

In the following key attempt has been made to furnish brief diagnoses which will serve to identify specimens. If carefully used, this key should enable one to identify most specimens, but every one of the characters used in it is subject to both individual and geographic variation. Hence, a nontypical individual of one form may be run down to another form in the key. In the accounts of species and subspecies, a detailed statement of the geographic range of each form is given. The statement of range should be consulted to check identification of specimens run down in the key.

1. Lateral stripe on anterior part of body confined to third scale row_____ Marcy's Garter Snake (*Thamnophis marcianus*)
1′. Lateral stripe on second and third scale rows_____ 2
2. Seven pairs of supralabial (or upper lip) scales_____ 3
2′. Eight pairs of supralabial scales_____ 5
3. Gastrosteges (large ventral scales of body) more than 153; posterior genials (chin scales) markedly longer than those of anterior pair; bright red markings but no pale flecks on dorsolateral area_____ Common Garter Snake (*Thamnophis sirtalis*)
3′. Gastrosteges fewer than 153; dorsal stripe red or yellow; pale yellowish flecks on skin between scales (see Fig. 23B) in area between dorsal and lateral stripes_____ 4
4. Dorsal stripe bright yellow_____ Coast Garter Snake (*Thamnophis ordinoides atratus*)
4′. Dorsal stripe red_____ Red-striped Garter Snake (*Thamnophis ordinoides ordinoides*)
5. Dorsal stripe bright yellow_____ 6
5′. Dorsal stripe absent, faint, or discontinuous_____ 8
6. Preocular (the scale in front of the eye) often divided on one or both sides; scale rows 21, 22 or 23, when counted across body at a point one-third of distance from head back to anus_____ Klamath Garter Snake (*Thamnophis ordinoides biscutatus*)
6′. Preocular not divided on either side; scale rows 19, 20 or 21 when counted across body at a point one-third of distance from head back to anus_____ 7
7. Red markings often present on sides or on ventral surface; lateral stripe sometimes red; iris often uniformly colored, clear gray; head narrower___ Coast Garter Snake (*Thamnophis ordinoides atratus*)
7′. No red in coloration; iris dark brown with narrow yellow margin around pupil; head wide and swollen_____ Mountain Garter Snake (*Thamnophis ordinoides elegans*)
8. Dorsal stripe absent_____ Southern California Garter Snake (*Thamnophis hammondii*)
8′. Dorsal stripe present but often faint and confined to anterior part of body 9
9. Scale rows 23 or 22 when counted across body at a point one-third of distance from head back to anus; size often very large (over three feet)_____ Giant Garter Snake (*Thamnophis ordinoides gigas*)
9′. Scale rows 21, 20 or 19 when counted across body at a point one-third of distance from head back to anus; size smaller (seldom as much as three feet)_____ 10
10. Dorsal stripe distinct for full length of body, faint, irregular, invaded by small rounded black spots; ground color pale brown; iris dark brown with narrow yellow rim around pupil_____ Wandering Garter Snake (*Thamnophis ordinoides vagrans*)

10'. Dorsal stripe faint, usually confined to anterior part of body; dorsal stripe and dorsal surface checkered with large squarish markings alternating with paler areas; iris uniformly brown or gray 11

11. Scale rows 21 both in neck region and across middle of body; dorsal stripe often confined to neck region ..... Moccasin Garter Snake (*Thamnophis ordinoides couchii*)

11'. Scale rows only 19, either across neck region or middle of body or both; dorsal stripe discernible, at least on anterior half of body ..... Oregon Gray Garter Snake (*Thamnophis ordinoides hydrophila*)

ACCOUNTS OF SPECIES AND SUBSPECIES

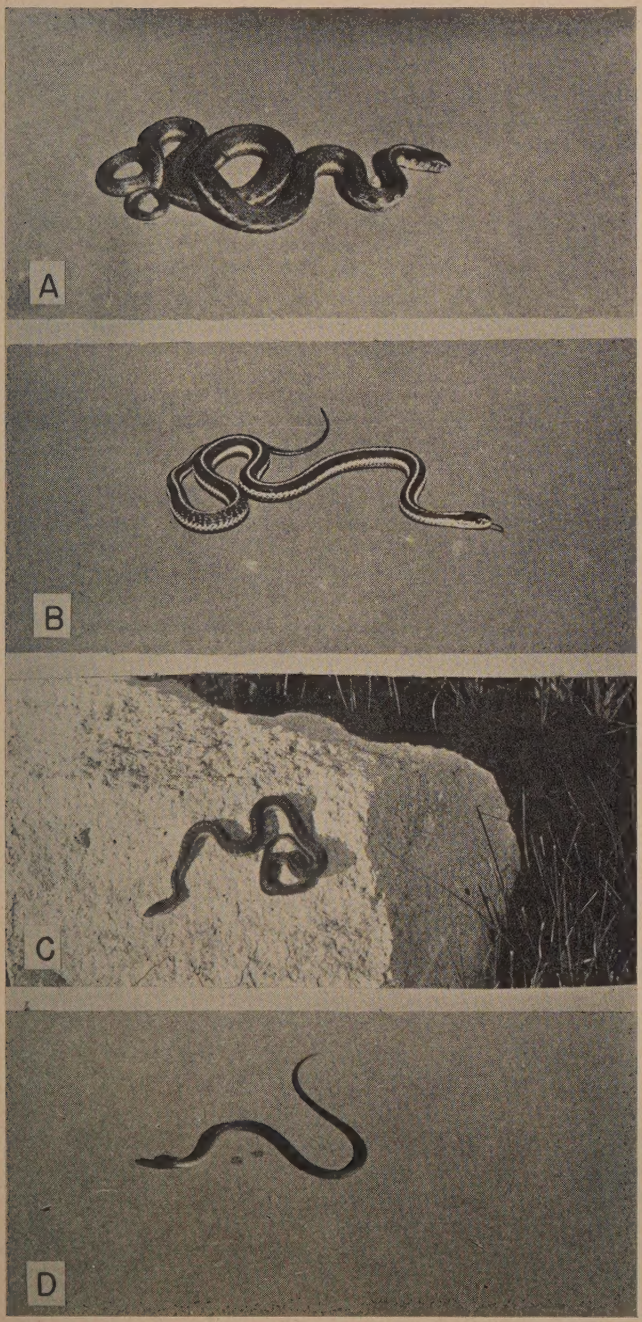
In the following accounts, a diagnosis is given for each form considered which will serve to distinguish it from all other kinds and a detailed statement of geographic range is made. Under the heading "habits" for each kind the general habitat preferences and manner of foraging are described, and, by way of illustration, specific instances are cited from published accounts, and from the field notes of the writer and other observers. Feeding records were obtained from an examination of a few more than 3500 snakes; 462 of these contained food, an aggregate of 945 items. Most of the snakes were museum specimens, and in many instances they may have been kept alive long enough after capture to digest any food in their stomachs. Small food items may have been overlooked in some instances. The digestive tracts could not be examined with thoroughness because it was necessary to avoid mutilating the museum specimens used. Usually food items could be readily detected by the bulges which they caused in the snakes' contours, or they could be felt by manipulating the ventral surface of a specimen. To examine, or, if necessary, remove food items, small incisions were made through the body walls and stomachs of the snakes. In snakes, feeding is infrequent, as compared with that of most other kinds of animals, and those which have eaten recently tend to stay in hiding, whereas those with empty stomachs are more apt to be out foraging where they will be found by the collector. In many the stomach contents were so well digested that accurate identifications could not be made.

All available feeding records are summarized in a table at the end of this paper. For most of the forms records are based on specimens taken in California or in the immediately adjacent portions of Oregon, Nevada, and Lower California, but for the common garter snake and the red-striped garter snake some records from northern Oregon, Washington, and British Columbia are also included, and for the wandering garter snake the records are mostly from outside of California, over its extensive range in the Great Basin and Rocky Mountain regions.

Common Garter Snake (*Thamnophis sirtalis* subsp.)

Diagnostic Characters

Size large in adults (up to 4 feet); dorsal stripe bright yellow, 1 2/2 scale rows in width, its edges straight, and sharply defined; dorsal ground color jet black, or occasionally dark gray; top of head black, dark olive or red; body marked with two series of transverse irregular red marks, mainly confined to skin between scales; lateral stripe dull yellow, situated on second and third scale rows; first scale



A. The moccasin garter snake. This dark-colored snake is common along many streams of the Sierra Nevada. It feeds upon fish, tadpoles and other aquatic prey.

B. The mountain garter snake. This brightly striped snake resembles in pattern the coast garter snake and the common garter snake, and like them it finds most of its food out of the water, either in damp streamside situations or occasionally in dry places.

C. The wandering garter snake is characteristic of the Great Basin region but extends westward into California. It is generalized in feeding habits and takes as prey both aquatic and terrestrial kinds of animals.

D. The Oregon gray garter snake replaces the closely related moccasin garter snake in northwestern California. It differs from the moccasin garter snake in paler coloration and more distinct dorsal stripe but resembles it in aquatic habits. It feeds upon trout and other fish and upon tadpoles.

FIG. 23

row dull, slightly darker than lateral stripe, or dusky or even jet black; ventral surface yellowish gray, not marked with black, rarely reddish on under side of tail (in individuals which are extensively marked with red dorsally); supralabials in seven pairs, infralabials in 10 pairs; scales in 19 longitudinal rows (this count obtainable anywhere on anterior two-thirds of body).

Distribution

Vicinity of permanent fresh water throughout most of the State, but absent from desert regions of southeastern California, and reaches southern limit in extreme northwestern San Diego County. Apparently occurs east of the Sierra divide only as far south as the Carson River drainage, and is absent from many small, isolated drainage systems of the arid region east of the Sierra Nevada.

Geographic Variation

As indicated in the diagnosis, the characters of this species are variable. Variation is both individual and geographic in its nature, but the geographic variation is the more striking. Series of individuals collected at a given locality are often fairly uniform in appearance but may differ markedly from series collected elsewhere at remote localities. At least two subspecies are represented by the California populations of *sirtalis,* but it is difficult to delimit their respective ranges because intergradation between them is gradual, extending over a large area. Thus most specimens are in a sense intergrades, intermediate between typical individuals of the different races. Variation occurs mainly in numbers of ventral scales on the body and tail and in the shade of the dorsal ground color, but the trends of variation in these characters are not entirely parallel. The numbers of ventral scales are smallest in snakes from the northern part of the State, and there is progressive increase in snakes taken farther south. In the coastal region these snakes have paler ground colors, gray rather than black, with red or reddish-gray heads. Series from the San Joaquin Valley and the Sierra Nevada are of darker color but often have brown rather than black heads. Those from the northeastern part of the State have the top of the head and the dorsolateral ground color jet black.

The differences between the supposed subspecies of *sirtalis* are minor ones as compared with those separating the members of the *ordinoides* complex. There is no evidence that these geographic differences in color and scale numbers are paralleled by geographic differences in habits. Everywhere in California that *sirtalis* occurs its habits are much the same, unlike *ordinoides,* whose geographic populations have diverged in habits in adaptation to their various environments.

Habits

The common garter snake is generalized in its feeding habits and apt to prey upon any small vertebrates which it can find and overpower. Individually these snakes are aggressive and voracious. In habitat preference the species is primarily a swamp snake, and is most abundant on low wet ground where there is dense vegetation. Along the margins of sloughs, along slow-moving watercourses, and in lush meadows along small coastal streams, it occurs in abundance seldom

attained elsewhere by snake populations in our western states. It is an excellent swimmer, and may take to the water in escaping its enemies. It can dive and hide under water, but it is more apt to swim on the surface. It occasionally forages under water in small stagnant pools, but it is not apt to forage in swift water as do some other kinds, notably the moccasin garter snake and Oregon gray garter snake.

In June a few miles south of Eugene, Lane County, Oregon, these snakes were found in abundance along a nearly dry creek bed with stagnant pools. They were crawling and swimming through the shallow water, apparently in pursuit of abundant tree-toad tadpoles, but quickly left the water and escaped into high grass as the observer approached each pool.

Late in July the writer observed these snakes along the course of Cottonwood Creek, Siskiyou County, California, a few miles from Hornbrook. At that time the creek had ceased flowing and water was confined to isolated pools along the sandy stream bed, which was densely shaded by willow, nettle and other riparian growth. The drying pools were teeming with small fish. In nearly every pool which the observer approached, one or several snakes were seen crawling or swimming about through the shallow water in pursuit of the trapped fish. Usually they saw the observer while he was still several yards away, and then darted out of the water into nearby thickets. Several which were caught regurgitated fish which they had recently eaten. Although both the mountain garter snake and the Oregon gray garter snake were known to occur in that general region, none could be found in this locality where habitat conditions were apparently unusually favorable for the common garter snake.

A captive individual repeatedly attacked an adult newt (*Triturus granulosus*) in a pool in its cage, but the noxious dermal secretion of the newt each time caused the snake to drop it.

At Prairie Creek Redwoods State Park, Humboldt County, California, these snakes were found in abundance in high grass at the edges of small meadows adjoining redwood forests. One of those caught had eaten an adult marbled salamander; another had eaten a red salamander (*Ensatina eschscholtzii*). They were difficult to capture or follow since they darted rapidly through the concealing grass.

These and other predation records as summarized at the end of this paper show the general trend of food preferences in this kind of snake. In keeping with its marshland habitat it seems to be mainly an amphibian feeder. The amphibians taken include yellow-legged and red-legged frogs, the introduced bullfrog, the toad, tree toad, the red salamander and the marbled salamander; apparently all these species are taken according to their local availability rather than through any definite preference on the part of the snake. Among invertebrates, the slugs, earthworms and leeches are favorite foods. Several kinds of fish are included in the diet. No definite instance of the common garter snake ever having eaten trout is known to the writer. It is probable, however, that at times small trout are taken when they are crowded into small stagnant pools along drying watercourses. Under such circumstances, the trapped fish are not apt to survive and the snake predation can not be considered a serious factor

in reducing the supply of fish which would otherwise be available to fishermen. Since *sirtalis* does not ordinarily forage in swift water, it is not apt to catch trout under normal conditions. It is not common along the best trout streams, since its preferred habitat is in meadows and marshland.

Wandering Garter Snake (*Thamnophis ordinoides vagrans*)

Diagnostic Characters

Size medium to large (22 to 39 inches in adults); dorsal stripe dull, yellowish or brownish, and suffused with dusky color, present for full length of body but sometimes narrow and broken; lateral stripes faint; dorsal ground color pale brown or tan with two alternately placed rows of small, well separated, black spots between dorsal and lateral stripe on each side; scales in 21 longitudinal rows (this count obtainable anywhere on anterior two-thirds of body); supralabials 8, 8; infralabials 10, 10; eye relatively small with heavily pigmented iris, which has a narrow, pale rim around the pupil; ventral surface marked medially with black, often in extensively continuous areas.

Distribution

In California confined to southern high Sierra Nevada and the region east of the Sierra Nevada in Mono County and Owens Valley; thence occurs generally eastward across the Great Basin and Rocky Mountain regions to Alberta, South Dakota and Oklahoma; northward across Oregon and Washington, and in British Columbia to higher altitudes than reached by any other genus of reptile in western North America.

Habits

Of the California specimens for which feeding records are available, one was found trying to swallow a young song sparrow; one contained a lizard (*Sceloporus graciosus*); one contained two slugs; one contained two metamorphosing tree toads (*Hyla regilla*). The apparent versatility in feeding habits suggested by these different kinds of prey is borne out by feeding records for the entire range: Seventy snakes contained an aggregate of 185 food items. Thirty-two snakes had eaten aquatic animals; 38 had eaten animals which are mainly terrestrial and were probably caught out of the water, although in most cases they were kinds characteristic of a stream-side habitat. Fish were eaten most often; 16 snakes had used this kind of food (*Apocope, Pantosteus, Cottus* and others which were unidentified); 9 had eaten tadpoles (*Hyla regilla, Bufo boreas, Scaphiopus hammondii*); 6 had eaten slugs; 7 had eaten earthworms; 6 had eaten mice (*Peromyscus maniculatus, Microtus montanus*); 6 had eaten leeches; 5 had eaten lizards (*Eumeces skiltonianus, Uta stansburiana, Sceloporus occidentalis* and *S. graciosus*); 3 had eaten frogs (*Rana cantabrigensis, Rana pipiens*); 4 had eaten birds (*Passerella, Melospiza, Junco*); 3 had eaten salamanders (*Ambystoma*); one had eaten tree toads (*Hyla regilla*); and one had eaten snails.

Habitat data for this snake have been recorded by many writers. In southeastern Washington it was found to be characteristic of water margin associations (Dice, 1916, pp. 303-312). In Malheur County,

Oregon, along the Owyhee River, it was often seen lying in the water at the edge of the river or swimming (Brooking, 1934, p. 95). In the Humboldt River Valley of northeastern Nevada, it was found to be confined to the immediate vicinity of permanent streams and to feed in the water (Ruthven and Gaige, 1915, p. 11). Along the Quinn River in northwestern Nevada, wandering garter snakes were found to be common in grassy marshes and generally took refuge in the water of irrigation ditches or pools (Taylor, 1912, p. 355).

At Burrard Inlet on the British Columbia coast, snakes of this kind were found to be restricted to the beaches, where they occurred about tide pools and fed upon fish, generally small cottids (I. M. Cowan *in litt.*).

In July, at the Deschutes River, Oregon, the writer observed many of these snakes and all were within a few feet of the water or actually in it; suitable habitat conditions were limited to the streamside area where there were alders, willows, grass and other riparian growth. Elsewhere sage and juniper were dominant and the terrain was arid. One of the snakes seen was crawling and swimming among submerged rocks out in the current, apparently foraging in the manner of the moccasin garter snake and related forms.

At the Owyhee River in extreme southwestern Idaho during July, the writer found these snakes in unusual abundance. They were feeding on minnows and tree toad tadpoles, which were concentrated in drying pools, and seemed to be doing all their foraging in the water.

In the arid Great Basin portion of its habitat, this subspecies is necessarily confined to the near vicinity of watercourses. Because of high temperature and seasonal fluctuation in volume of water and the small size and isolation of drainage basins, these streams have meager aquatic faunas. The scarcity of aquatic prey may promote habits of terrestrial foraging in the wandering garter snake. In any case it appears to be far more versatile in its feeding habits than any of the other kinds here discussed. It may take mice, lizards, frogs, toads, tadpoles or fish, according to their availability. The method of foraging in streams where trout occur strongly suggests that it may sometimes catch them, though no actual records are available. In the State of California, however, this snake is so restricted in range that it probably does not figure importantly as a trout predator.

Klamath Garter Snake *(Thamnophis ordinoides biscutatus)*

Diagnostic Characters

Size large (29 to 39 inches in adults); dorsal stripe 1 2/2 scale rows wide, yellow or orange yellow, its edges not sharply defined; dorsal ground color dark gray or brown, nearly black; conspicuous pale yellowish flecks on sides; chin white; ventral surface of body and tail pale grayish yellow, often irregularly blotched medially with black; supralabials in eight pairs; scales in at least 21 longitudinal rows (this or a higher count obtainable anywhere on anterior two-thirds of body), with, in about half the specimens, an additional scale row intercalated for a short distance between the fourth and fifth on one or both sides, making a total of 22 or 23 rows where the maximum number occurs (usually about one-third of the distance from head back toward

posterior end of body); ventral scales 184 to 160; iris dark brown, with narrow, pale yellow margin encircling pupil; preocular scale on one or both sides of head often divided by horizontal suture into upper and lower portions.

Distribution

Klamath Lakes basin, Oregon, and southwestward along Klamath River to the California State line, eastward through Goose Lake basin to vicinity of Warner Lakes. Confined throughout the arid region it inhabits to immediate vicinity of permanent streams and lakes; in local occurrence confined mainly to rocky places, less partial to swamps or meadows.

The Klamath garter snake varies throughout its range, and on the west along Klamath River merges into the Oregon gray garter snake by reduction in size and in number of scale rows and ventral scales, dulling of pattern, and changes in body proportions. On the east it merges with the wandering garter snake, and in the southeast, in the Warner Lakes region, it intergrades with the mountain garter snake through reduction in size, numbers of ventral scales and scale rows, and change to more slender body form.

Habits

Van Denburgh and Slevin (1918, p. 25) described this snake as occurring in enormous numbers in the vicinity of Klamath Falls. They stated: "We counted a hundred and eighty on a small rock about a yard in diameter in Link (Klamath) River, and at another point on the same river, caught fourteen with one grab with both hands."

During the summers of 1934, 1935 and 1936, the writer made several trips to the upper Klamath River, but nowhere found these garter snakes very abundant; often, in the most favorable locations, hours were spent searching before even one could be found.

On May 6, 1934, eleven were found along the river gorge below Spencer Creek; all were on basalt boulders within five feet of the edge of the water. Several were in small patches of tules growing among the rocks and offering shelter. None could be found along the river above the gorge north of the bridge where U. S. Highway 97 crosses. There the shore was swampy, rising gradually to a meadow with no rocky margins, and this habitat was occupied by the common garter snake.

Several miles farther down the river, on June 9, 1934, sixteen were found during a day's collecting. There the river gorge was several hundred feet deep, and the stream itself was swift, only 30 to 50 feet wide, with marginal areas of smooth basalt boulders. Because the canyon walls rose abruptly from the river, riparian growth was limited to a few small, scattered patches of tules in sheltered situations at the edge of the water, and there were occasional short gravel bars. All the snakes were on rocks at the edge of the river—in no instance more than ten feet from the water. The larger snakes were all taken among boulders, but juveniles were taken among smaller rocks on gravel bars. In attempting to escape, the snakes made for the water and, if they succeeded in reaching it, swam rapidly down to the bottom.

On June 10 and 11, 1935, in the river gorge above the mouth of Spencer Creek and along the lower portion of the creek's course, 30 were seen. The gorge is narrow and boulder-strewn. All the Klamath garter snakes seen were in rocky situations and most of them were on boulders within eight feet of the river's edge. Eleven common garter snakes seen in the same general locality were all in grassy situations or in parts of the creek adjoining meadow habitat.

On July 4, 1934, near Adel, Lake County, Oregon, seven were seen in the rocky canyon of Deep Creek, where they were found on boulders at the edge of the water or crawling among submerged rocks in the swift current. When alarmed they attempted to escape by diving and hiding beneath rocks under water. On the same day, at the Sprague River near Beatty, Klamath County, Oregon, four were collected along the river, there flowing through an open, level valley, and bordered with thickets of willow and cottonwood. All were found in grass about 100 feet from the stream; two were coiled under a heavy timber, the others were on marshy ground near a willow thicket.

This evidence seems to show that the Klamath garter snake is, in general, confined to the immediate vicinity of permanent streams, an ecologic restriction imposed upon it by the generally arid and inhospitable character of the region it inhabits. It is also largely confined to portions of watercourses which are rocky or boulder-strewn, and it avoids the extensive areas of marshland within its geographic range. It is mainly dependent on fish and adults and tadpoles of frogs for food. Trout and other kinds of game fishes may be eaten by it, but those fish identified in the stomachs examined included only sculpins, suckers and minnows, not valued by fishermen.

Oregon Gray Garter Snake *(Thamnophis ordinoides hydrophila)*

Diagnostic Characters

Size medium (usually between 17 and 32 inches in adults); dorsal stripe dull yellow, indistinct, or sometimes entirely absent, not sharply set off from bluish gray or brownish gray dorsolateral area, which has a checkered pattern of two rows of alternately placed black blotches on each side; chin white; lateral stripe dull, grayish yellow, or absent; iris pale, uniformly grayish or brownish; scale rows on body 19 or less frequently 21 (one or the other of these counts obtainable anywhere on anterior two-thirds of body); supralabials in eight pairs; infralabials in ten pairs; ventral surface immaculate or nearly so, pale with pinkish or purplish suffusion posteriorly.

Distribution

Drainages of the Umpqua and Rogue rivers in southwestern Oregon, and of the Smith, Klamath, Mad, Eel, Mattole, Garcia, Noyo and Russian rivers in California; also northwestern portion of Sacramento River drainage. Intergrades with the Klamath garter snake by increase in size, increase in numbers of scale rows and ventral plates, and darkening of ground color with accompanying brightening of stripes, along the upper Klamath River between the mouth of the Shasta River and the Oregon State line. Intergrades with the moccasin garter snake in the upper Sacramento Valley, by increase in size and in numbers of scale

rows and ventral plates, and dulling of stripes. A population with a bright yellow dorsal stripe and a dark ground color, somewhat resembling the mountain garter snake in superficial appearance, occurs in Trinity and eastern Mendocino counties. In this region, the pale color of the iris and the narrow, elongate shape of the head serve to distinguish this subspecies from the mountain garter snake.

Habits

The many records of stomach contents of the Oregon gray garter snake summarized at the end of this paper are supplemented by a considerable amount of evidence obtained from direct observation of the foraging. To illustrate the habitat preferences and general field behavior of these snakes, observations are recorded below for some of the localities where they were found in unusual abundance.

On April 19, 1934, at Trail Creek, 16 were collected and about the same number escaped. None was more than two feet from the water; several were swimming when found but the majority were lying on rocks at the edge of the water or at midstream. A large one in the process of foraging was slowly feeling its way over and around submerged rocks. In escaping, some of the snakes dove and hid beneath rocks, but most of them swam to the opposite side of the creek and crawled out of the water to hide among rocks, piles of driftwood, and tangled roots.

On July 27, when the locality was again visited, the snakes were nearly as abundant as before (21 collected), and all seen were in the water or within two feet of its edge. In attempting to escape they invariably dove and hid beneath rocks on the bottom; the water level had receded well below the piles of driftwood and riparian growth, which were no longer readily accessible for shelter, as they had been earlier in the season.

On May 23, 1935, at Lobster Creek, Rogue River, one was caught as it was crawling into a brush fence at the edge of a plowed field about 75 feet from the creek. It contained a sculpin, and evidently had left the creek in order to find a sheltered spot where it could digest this food. Of the few others found on other occasions at similar distances from water, some, likewise, had aquatic prey in their stomachs and in every instance obviously were seeking shelter late in the day or immediately preceding a storm.

At the Sacramento River, seven miles north of Dunsmuir, Siskiyou County, in June, 1934, one, seen on rocks at the edge of the water, dove and escaped but later at the same place a splashing sound revealed the presence of the snake struggling with a six-inch trout which it had caught. It was holding the fish by the throat so that the gill covers were held shut and circulation of water through the gills was prevented. The reptile was pushing the fish shoreward, apparently trying to slide it out of the water onto the rocks. At intervals the trout struggled vigorously and dragged its captor partly out into the current. The snake was twisted over on its back and would have been swept downstream but for the fact that its tail was securely wound among the rocks. It played the fish, using the same principle as a fisherman with rod and reel in allowing its body to yield somewhat to the fish's struggles, yet exerting constant pressure upon it. After

about ten minutes the fish appeared to be exhausted and its struggles had nearly ceased. Then the snake worked its jaws around the front of the trout's head and commenced swallowing it.

At Redwood Creek, Humboldt County, California, in July, 1935, 25 were seen, all of them at the edge of the water, on rocks at midstream, or actually in the water. In escaping they almost invariably swam out into deep water and hid under submerged rocks or swam into willow thickets overhanging the stream. A large one, cornered in a narrow inlet by the writer wading toward it from the middle of the stream, chose to dive between his legs rather than to seek shelter among boulders on shore. Another, found foraging, was feeling its way among pebbles beneath water 18 inches deep in the swift current of a riffle. Factors apparently favoring the abundance of these snakes at this locality were the large permanent stream of clear water and many large, still pools, shallow riffles, and pebbly beaches. Trout were abundant in the stream; yellow-legged frogs were common along the shore, and their tadpoles were swarming in the shallow water.

On July 17, 1936, at the Mattole River, Humboldt County, 25 were seen. One was standing on its tail in the middle of the stream, with only its head protruding above the surface. It drew back and hid beneath a submerged rock when approached. One, encountered swimming in the middle of a deep pool about 30 feet from shore, dove and swam along the bottom. The others were seen at the edge of the water. Those which succeeded in reaching the water almost always dove and hid among submerged rocks; some emerged after a few seconds and tried to hide among rocks on shore. In this locality the stream was 30 to 50 feet wide, with a rocky bed, wide pebbly beaches, extensive stretches of shallow water, and occasional deep pools.

At Cobbs, Van Duzen River, Humboldt County, July 1, 1936, 19 were seen. One was found coiled under a rock at the edge of the water late in the afternoon; another was found in gravel five feet from the stream; all the rest were found in the water or succeeded in reaching it before they could be caught. One escaped into a willow thicket after it swam across a pool. The snakes were scarce or entirely absent from extensive stretches of the stream where it was bordered by barren gravel deposits with no riparian growth.

On June 29 and 30, 1936, along the south fork of the Eel River near Piercy, Mendocino County, 44 were seen. All were in the water when found or took to it in attempting to escape, except for one caught before it had time to dive from the boulder on which it was basking. The snakes seemed to avoid stretches of open sandy beaches but were especially common where there were shallow rocky pools along the shore. Trout and tadpoles of the yellow-legged frog were common there.

At many other localities gray garter snakes were found under somewhat similar conditions but in smaller numbers. At all places where they were found, these snakes were closely restricted to streams having rocky beds and a permanent flow of clear, swift water. They depend on water both as a place of refuge from danger and as a foraging place.

Snakes of this kind seem to be restricted to the vicinity of streams where there are trees and bushes near the water, furnishing shade and

shelter, but do not occur where the streams are continuously walled in by dense vegetation. Exposed rocks in marginal streamside areas or at midstream, accessible for basking places, seem to be an ecologic necessity. In heavily forested regions where streams are so well shaded that basking places are scarce, the snakes are correspondingly scarce. Because water temperatures in which the gray garter snake occurs are generally below the optimum for maximum activity, prolonged foraging in the water would result in decreased activity. Probably intervals of basking are necessary to maintain the snake's body temperature at a level which will allow efficient foraging, except in unusually warm weather.

It is evident that the gray garter snake is exceedingly aquatic in its habits. All the food is found under water, or among rocks near the edge of the water. Ninety-six of the specimens examined, representing 27 widely scattered localities, had eaten a total of 139 different items. Of these items, 129 were animals of kinds which must have been found under water by the foraging snakes; the rest were all yellow-legged frogs *(Rana boylii)*, known to be closely restricted to the vicinity of streams, so that some were likely caught under water also.

Fish and their eggs and yellow-legged frogs comprise more than 80 per cent (in number of individuals taken) of the recorded food, but larvae of salamanders (*Dicamptodon, Triturus*) are occasionally eaten. Fish were eaten more than twice as often as *Rana boylii,* and of the latter species, tadpoles were much more often preyed upon than were metamorphosed frogs. Recognizable fish remains consisted almost entirely of sculpins and young trout; the former were eaten almost twice as often as the latter. The trout predation is thus compensated, in part at least, by predation on sculpins, which are themselves notorious destroyers of trout spawn and young fry. Probably fish are seldom or never caught in open water; the snakes hunt among rock crevices and crannies on the bottom, and catch animals there which could easily escape them in the open. Sculpins, largely confined to this rocky bottom habitat, are, therefore, caught more often than trout, which spend much of the time up from the bottom, in the current. This subspecies is responsible for nearly all garter snake predation on trout in northwestern California.

Moccasin Garter Snake (*Thamnophis ordinoides couchii*)

Diagnostic Characters

Size medium to large (length usually between 22 and 38 inches in adults); dorsal stripe dull yellow, suffused with dusky coloring, usually absent on posterior portion of body and tail; lateral stripe distinct, dull yellow; dorsolateral area between dorsal and lateral stripes brown, with two rows of alternately placed black marks, usually larger than interspaces so that their corners overlap slightly; these spots tend to be square; supralabials brownish superiorly, pale inferiorly, marked posteriorly with black; scales usually in 21 longitudinal rows (this count obtainable anywhere on anterior two-thirds of body); supralabials 8, 8; infralabials 11, 11 or reduced to 10 on one or both sides; gastrosteges average more numerous than in any other garter snake (183 to 162); eyes relatively large, with pale, yellowish, uniformly colored iris.

Distribution

Streams of the Sierra Nevada from the Pit River south to the Tehachapi Mountains, but does not occur at high altitudes—mainly confined to Transition and Upper Sonoran Life Zones. In habitat preferences closely restricted to vicinity of running water and usually to streams which are permanent throughout the year. The moccasin garter snake intergrades with the Oregon gray garter snake in the Sacramento Valley, and intergrades with the giant garter snake along the eastern edge of the San Joaquin Valley. In the extreme northern part of its range the moccasin garter snake has more ventral scales, has eleven pairs of infralabial scales, more distinct dorsal stripe, and more distinctly checkered pattern, and often has extensive black markings on the ventral surface. All these characters undergo gradual change toward the southern part of the range, and in the trend of its characters this subspecies approaches the southern California garter snake, which occurs south of the Tehachapi Range.

Habits

At Lake Britton, Pit River, in Shasta County on a visit to the Burney Creek State Fish Hatchery in May, 1934, I was told by the foreman that garter snakes of this kind were abundant in the vicinity and were a serious pest because of their destruction of small fish. I was shown a preserved specimen killed in the act of swallowing a trout, and the foreman pointed out a rock pile just above high water mark where he believed that a colony of the snakes hibernated, since they were numerous there in spring.

In a letter to the late Dr. Joseph Grinnell, dated June 1, 1935, I. L. Hussey of the California Division of Fish and Game wrote of these snakes: "They are very plentiful along the headwaters of the Carson River and its tributaries, and take heavy toll of trout from these streams. They often invaded our hatchery at Markleeville and took fry from the troughs. One about 16 inches in length was caught by Mr. Tutt; upon opening it he counted 21 fry from its stomach, which it had taken from a trough."

At the San Joaquin Experimental Range in the dry foothill country of the digger pine belt, these snakes were found in an atypical habitat, for the streams where they occurred were transitory and dried up almost completely in spring or early summer. In the 1938 season, when observations were made, the first garter snake was found on March 22, but few were seen until mid-April. During the latter half of April, and continuously through May and early June, many were seen daily, and they could be found at almost any time by walking for a short distance along one of the small creeks. Nearly all those seen were along the edge of water, but some were found in grass a hundred yards or more from water. Others were found at isolated pools, such as those in old wells or mine shafts, where an abundant food supply of tadpoles was available. After the first week of June the snakes suddenly vanished just at the time when the streams were drying up. Throughout the remainder of June, July and August, only a few were seen in the locations where they had been so abundant earlier in the season. Two reservoirs on the Range were tenanted all summer by a few which could be seen daily, but there were no concentrations in

these places. The remainder of the population evidently underwent a sudden cessation of activity with the disappearance of their habitat and food supply (certainly a normal seasonal occurrence there). The active season in this foothill locality is hence less than two months annually. Evidence that these snakes actually remain in the vicinity throughout the year, and merely tend to keep under shelter during the dry season, was furnished by the few seen during the summer. One was seen in mid-July on one of the few cloudy days of the summer; at 5.30 p.m. it was emerging from a squirrel burrow near the edge of the dry creek bed. Four days later, at 6.15 p.m., another was seen in the mouth of a squirrel burrow near the creek bed. One day in August, a juvenile was seen to dart from beneath an overhanging rock, across the sand of the creek bed, in pursuit of a young tree toad which eluded it and escaped.

Amphibians comprised all the recorded food at this locality; of the items eaten, 70 were tadpoles and two were larval salamanders. The remainder were all amphibians of terrestrial kinds, most of them newly metamorphosed—ten toads, two tree toads, and one spadefoot toad. At this locality the moccasin garter snake seems to depend almost entirely on tadpoles in the absence of other preferred foods, and is limited in its time of foraging to the brief part of the year when tadpoles are available.

At all other localities where these snakes were found, there were permanent streams affording a continuous habitat and varied food supply with no evidence of diminished activity during the hot, dry summer.

The aquatic tendencies of this subspecies are emphasized by the field notes of persons collecting it. Grinnell, Dixon and Linsdale (1930, p. 151) wrote of it in the upper Sacramento Valley: "These snakes frequented brush and driftwood at the edges of the streams." Under the heading of *Thamnophis ordinoides atratus* (specimens in Museum of Vertebrate Zoology identified as *couchii* by the writer) they remarked (*loc. cit.*): "One from near Red Bluff was in a thicket of sycamore shoots close to the Sacramento River. At Cone's one was found at the edge of a field ["along creek" (Linsdale MS)] one was at the side of an irrigation ditch, and the other beneath a board close to a ditch."

At Yosemite Valley, on June 25, 1915, C. L. Camp observed (MS) that these snakes almost always took to the water when alarmed and were difficult to capture.

Of a series collected in the Little Kern Lake region during the summer of 1934, W. B. Richardson wrote (MS) that they were found in the water of the lake, among aquatic weeds along the edge of the river, and in a wet, brushy area between the lake and the river.

At Hat Creek, Shasta County, in June, two were found under typical habitat conditions. A juvenile was coiled on a rock at the edge of the water. An adult swam to the bank and crawled out of the water momentarily, then, perhaps slightly alarmed, it dove and swam down at a steep angle toward the base of a clump of tules submerged to a depth of several feet. In May at Lake Britton, several were seen coiled on rocks within a few feet of the water. Those which attempted to escape made for the water and dove. Four taken in May near the

Sacramento River in Shasta County were swimming in an irrigation ditch or lying at the edge of the water. Five seen at the Susan River Canyon east of Susanville in June were found on boulders at the edge of the stream, except for one crawling through grass several yards from the water. Two escaped by diving and hiding under submerged rocks. Of two found at this same locality in August, one was crawling under a submerged rock at the edge of the water, the other was lying in a shallow pool.

These snakes were found in greatest abundance along the Middle Fork of Feather River near Cromberg, Plumas County, in August. The river was there moderately swift, with a rocky bed, and with many large projecting boulders. These boulders often supported grass tussocks, which were favorite shelters for the snakes. Most of the garter snakes seen were in or near small pools along shore protected from the full force of the current; in many of these pools small trout and suckers were abundant. Of forty moccasin garter snakes found here for which data were recorded, 32 were actually in the water or were coiled on protruding boulders at midstream, seven were among rocks at the edge of the stream, and one was in grass beneath trees several yards from the water. Residents of Cromberg were familiar with this "fish snake" or "black water snake," which they unanimously condemned as a destroyer of trout.

Several snakes were observed in August along the Truckee River, Nevada County. Three were found lying at the edge of the stream or partly in the water. Another seen swimming in shallow water near shore dove and attempted to hide under a rock when it was headed off from deep water. One dove when alarmed and lay on the sand bottom in the current at a depth of about a foot. Another was lying on the bottom in shallow water when first seen. A large one was seen basking on a boulder. The writer waded across the stream toward it; after he had approached within a few feet the snake suddenly lunged toward him and toward the water, striking out with mouth open as it did so, though no threatening move had been made toward it.

Most of the moccasin garter snakes collected were of savage temperament and the writer was often bitten while catching them. When picked up by the body or tail, the snake would not squirm to free itself, but immediately would draw itself up in an S-shaped loop in striking position, facing its captor and flattening its head and body. It would then dodge and strike back if attempt was made to catch it by the head.

Snakes of this kind occur mainly along swift, rocky streams of the foothills and mountains. As nearly all foraging is done in the water, aquatic animals comprise most of the food and are usually caught beneath and among submerged rocks.

Trout streams are favorite habitats and trout are commonly preyed upon; of the 16 individual fishes in stomachs examined by the writer, 11 were tentatively or positively identified as trout. The bad reputation of California garter snakes as fish destroyers is based almost entirely on the depredations of this snake and the closely related Oregon gray garter snake. Significantly, no slugs, worms, adult salamanders, lizards, mice, birds, or other small terrestrial animals such as are commonly preyed upon by other garter snakes were found to be included in the diet of the moccasin garter snake. It is specialized for

finding and catching its prey in the water. The two most important food sources—tadpoles and small fish—are taken according to local and seasonal availability.

Giant Garter Snake (*Thamnophis ordinoides gigas*)

Diagnostic Characters

Size larger than in any other garter snake (up to five feet); dorsal stripe variable, faint and dull yellow, sometimes hardly discernible; dorsal ground color brown with well separated and rounded black spots; lateral stripes yellowish, usually distinct but occasionally lacking; supralabials in eight pairs; scale rows in 23 or 21 rows on anterior two-thirds of body; preocular scale usually undivided.

Distribution

Floor of the San Joaquin and southern Sacramento valleys, California, from Antioch and Sacramento south to Buena Vista Lake; confined to vicinity of permanent fresh water. In the Buena Vista Lake region these snakes more often have 23 scale rows than they do in the northern part of the range. Suppression of the stripes is more frequent in the northern populations. Along the eastern edge of its range, in the Sierra Nevada foothills, the giant garter snake intergrades with the moccasin garter snake by reduction in body size, reduction in numbers of scale rows, and increase in numbers of ventral scales. The Coast Range divide separates the giant garter snake from the southern California garter snake on the west, and these two closely related forms do not intergrade geographically.

Habits

One of these snakes, collected near Los Banos, Merced County, in June, had eaten a fish which was too well digested to be identified. Another from near Lanare, Fresno County, in June, had eaten a small carp (*Cyprinus carpio*). These are the only definite feeding records available. Field observations indicate this subspecies is probably more aquatic in its habits than are any of the other California garter snakes. Van Denburgh (1923, pp. 79 and 843) stated that he had seen them in Buena Vista Lake in tule patches at distances from shore, sunning themselves in considerable numbers, but that they were so shy they were hard to shoot, sliding into the water at the least alarm.

In April, 1936, the writer hunted them along irrigation canals between Buttonwillow and Tupman, Kern County. Although they were fairly common they were so alert and timid that the usual method of catching garter snakes by hand after a stealthy approach invariably failed. The banks of the canals were steep and overgrown with weeds, tules and willows. It seemed to be characteristic of the snakes that they basked directly over the water partly screened from view by the dense tangle of vegetation, and when alarmed plunged downward into the opaque water. They usually did not reappear for several minutes and then only after swimming for distances under water. Usually they took alarm and dove while the observer was still 30 feet or more away, and often before they had been sighted basking on the bank. Those seen in the water swam easily, with slow undulations, maintaining position against the current with little effort.

Wherever these snakes were encountered by the writer, bullfrogs and carp were so abundant that they were the most conspicuous animals of the aquatic fauna. Probably these two introduced species now figure importantly in the food of the giant garter snake. Judging from the markedly aquatic proclivities observed, most of the food must be secured in the water. Fishes and amphibians probably comprise nearly all the food.

The valley floor habitat does not include any trout streams, hence this snake is not a trout predator. Bass, sunfish, catfish, carp and various native minnows are common in its habitat, and all of these may be included among the species preyed upon.

Southern California Garter Snake (*Thamnophis hammondii*)

Diagnostic Characters

Size medium to large (ranging from 22 to 38 inches); no dorsal stripe; lateral stripes distinct, yellowish on second and third scale rows; dorsal ground color brownish gray with four rows of alternately placed black spots, which are small and well separated; scales in 21 longitudinal rows (this count obtainable anywhere on anterior two-thirds of body); supralabials 8, 8; infralabials 10, 10; eyes relatively very large, with pale, uniformly colored irises; chin white; belly immaculate, with pinkish suffusion posteriorly.

Distribution

River systems mainly west of inner Coast Range divide, from Monterey Bay, California, southward through Sierra San Pedro Martir in northern Lower California; also occurs east of the divide along the Mojave River, and in a few other streams which drain interiorly. Confined to near vicinity of permanent fresh water. Does not intergrade with any other form, but is closely related to *Thamnophis ordinoides couchii,* from which it is separated by the Tehachapi Mountains.

Habits

Grinnell and Grinnell (1907, p. 50) wrote: "This snake feeds on tadpoles, small frogs, and fish. We have seen a garter snake so gorged with tadpoles that when alarmed it had to give up some of its cargo, the released tadpoles wriggling out of its mouth apparently none the worse for wear."

Klauber (1924, p. 16) wrote: "As an indication of the voracious habits of these snakes, it may be mentioned that one moderate sized individual undisturbed at being caught and placed in a glass quart jar, ate thirty *Hyla regilla* as rapidly as they were handed in." The same author recorded (1931, p. 72) that one about three feet long had eaten an adult toad eight inches long, a juvenile contained a full-grown tree toad, and one contained a tree toad and a worm.

The writer discounts Stephens' (1921, p. 63) statement that the food includes insects, since no specific instances are cited, and no corroborative data are supplied by other observers. Insect fragments frequently have been found in garter snake stomachs by the writer, but in every instance it was evident that these indigestible chitinous remains were residual from the stomachs of small insectivorous vertebrates—fish, amphibians, or lizards—which had been eaten by the snakes.

Specimens of this snake in the Museum of Vertebrate Zoology were collected under the following habitat conditions: San Lucas, Monterey County, in September—"in willow sprouts near water"; Salinas River, Monterey County, in September—"on dry river bottom"; Lower California—"among damp grass on marshy ground"; "curled in bare spot near creek"; "under willows near creek"; "at edge of creek under willow bush"; "among damp grass and rocks at edge of stream"; "at water's edge among loose rocks and sand"; "in 'spear grass' near marsh."

Along the San Benito River in April, 1936, these snakes were found to be rare and restricted to places where the stream channel was cut through loose bed rock with deep pools which remained through the summer. Along most parts of the river the banks were open with no riparian growth and there was but little aquatic life. During the summer of 1936, D. H. Johnson and F. G. Palmer found southern California garter snakes in numbers along certain parts of the San Benito River. Those seen usually escaped by diving into deep pools, where they hid in inaccessible places, often beneath willow thickets overhanging the water.

This species seems to be most common along streams having rocky beds bordered by thickets of willow, or other dense vegetation furnishing shelter. Streams where it occurs often become almost dry or reduced to series of disconnected pools in summer, and within its range watercourses are in general smaller and less permanent than are those within the ranges of the Oregon gray garter snake and moccasin garter snake in the northern part of the State. Like these forms, the southern California garter snake is a potential fish predator, and locally it may be even more important in this respect because where it occurs, fish are apt to be in small streams or pools where they are easily caught. An instance of predation on trout by a snake almost surely of this species was seen in the Santa Anita River by Richard S. Croker, who recorded that the snake, having caught the six-inch fish under water, held it firmly near the head and took it ashore alongside a rock on damp sand. As its struggles subsided, the snake shifted it about and swallowed it head first, taking nearly half an hour in the process.

On the whole, however, strictly aquatic prey species are less numerous and generally distributed within the range of this species than they are farther north, and their lack is compensated in the snakes' diet by increased predation on tree toads and their tadpoles, usually abundant in southern California streams.

Mountain Garter Snake *(Thamnophis ordinoides elegans)*

Diagnostic Characters

Size medium to small (22 to 34 inches in adults); dorsal stripe bright yellow, 1½ scale rows wide, contrasting with black ground color between dorsal and lateral stripes; chin white; lateral stripes pale yellow; iris dark; scale rows on body 21 to 19 (one or the other of these counts obtainable anywhere on anterior two-thirds of body); supralabials in 8 pairs; infralabials in 10 pairs; ventral surface pale, sometimes marked with black; top of head black, paling to brown on snout.

Distribution

Southwestern Oregon from south end of Willamette Valley southward through Umpqua and Rogue River basins; in California occurs in northern part from Warner Mountains westward to eastern Mendocino County, south through coast ranges to Mount St. Helena, and throughout the Sacramento Valley; entire Sierra Nevada except at high altitudes in southern part. An isolated population occurring in southern California is confined to high altitudes in the San Bernardino Range. Occurs also in extreme western Nevada, along Smoke Creek and the Truckee and Carson rivers.

Habits

Grinnell, Dixon and Linsdale (1930, p. 152) stated that one was seen in July at Willow Lake, Lassen County, California, eating a shrew which was caught in a trap, and another at Eagle Lake, Lassen County, in May, disgorged a fish a quarter of an inch long.

Richardson (1915, p. 433) recorded that at Tallac, El Dorado County, California, these snakes were frequently seen along small streams catching minnows *(Agosia* [=*Apocope*] and *Richardsonius),* and one contained a frog *(Rana pipiens).* (These observations may be based partly upon the moccasin garter snake, as the author did not recognize its distinctness from the present form.)

Grinnell (1908, p. 166) wrote of this form in the San Bernardino Mountains that it was most abundant along the shallow margins of streams and in ciénegas but that he saw a good many on dry mountain sides as much as a quarter of a mile from water. Grinnell, Dixon and Linsdale (1930, p. 152) found it in the Lassen Peak region in the following situations: in willow clump close to clover field; under rock; in bottom of dry well; on ground on ridge covered with yellow pines; along rocky canyon walls; at nearly dried up pool in creek bed, where minnows and tadpoles were concentrated.

Field notes of collectors for the Museum of Vertebrate Zoology show capture of these snakes under the following circumstances: in small lake at Tuolumne Meadows, Yosemite National Park; in swampy meadow at Kings River Canyon; in meadow at 4400 feet, on divide 12 miles north of Yolla Bolly Mountain, Trinity County; dry ridge in yellow pine association near Oroville, Butte County; in yellow pine forest on South Yolla Bolly Mountain, Tehama County; in willow patch at Emerald Lake, 9340 feet, Tulare County.

The writer's field notes record captures as follows:

For Oregon specimens in Jackson County: under board a few feet from intermittent stream near Beagle; in water at Trail Creek; on dry ridge in yellow pine and manzanita association half a mile from Squaw Lake; on bank two feet from water at Applegate River; in nearly dry pool of intermittent stream at Cottonwood Creek near Cole; on ridge in Garry oak and buckbrush half a mile from the nearest water, south of Medford; dry hillside near flume, half a mile from Little Applegate River; road, 100 yards from water near junction of Little and Big Applegate rivers; under board on a sawdust pile 100 feet from creek near Hyatt Dam; clearing near buildings, 200 feet from Emigrant Creek. In Curry County: thicket of thimbleberry, alder and willow, a few yards from Burns Creek; in dry grass 100

yards from Rogue River, and another on bank of old placer workings more than a quarter of a mile from water at Solitude Bar; in wild grape bushes ten feet from Rogue River at Agness. In Lane County: dry, rolling meadow land one-quarter mile from creek near Eugene; meadow at edge of stream near middle fork of the Willamette River.

In California, snakes were found in Siskiyou County: in road on dry hillside about one-quarter mile from water at Applegate River; in short grass at edge of Butte Creek near Mount Hebron; in grass at edge of creek near Weed. In Lassen County: Susan River eight miles west of Susanville (three juveniles, one in the water, one crossing a gravel bar, and one in a rock crevice near the edge of the water); Ash Creek (23 adults and young, on grassy banks of creek and on branches and logs over the water). In Modoc County: in marshy field near Adin, 100 feet from Rush Creek; rocks at edge of Pit River, at Canby Bridge. In Shasta County: in bush beside intermittent stream of Salt Creek, seven miles north of Redding. In Tuolumne County: near Strawberry (one in grass at edge of creek, and one under board near edge of creek). In Placer County: in grass near edge of Truckee River. In Mono County: under boards 15 feet from Rush Creek.

In Nevada in Douglas County: dead on road at least a quarter of a mile from nearest water at Stateline, Lake Tahoe.

As shown by these notes, this subspecies displays to a certain degree the instinctive tendency common to all garter snakes, to seek out the vicinity of water. However, it is not strictly aquatic and does not depend directly on the presence of water either as a source of food or as a place of escape. In its mainly terrestrial habits it contrasts sharply with the more aquatic kinds such as the moccasin garter snake and the Oregon gray garter snake. With few exceptions, young mountain garter snakes were found in the immediate vicinity of streams. Apparently they have a stronger predilection for riparian conditions than have adults. Small animals suitable to them as food—slugs, earthworms and newly metamorphosed amphibians—are apt to be abundant in such moist situations. Adults have been found more often in dry forests at distances from water. Relatively large animals eaten by them, which might have been caught in such dry situations—lizards, mice, toads, and adult tree toads—make up most of the bulk of the recorded food, though they comprise less than half the total number of animals eaten. Slugs exceed all other kinds of animals in numbers eaten, but they make up only a small portion of the total volume of food taken by the snakes examined. All slugs eaten were small (mostly less than half an inch long) and were found in young or half-grown snakes taken in damp, meadow, or streamside habitats.

In the arid portion of its range—Modoc and Lassen counties, California, and extreme western Nevada—the mountain garter snake's aquatic tendencies are much stronger than in other parts of its range. In this region, dominated by juniper and sage, or by sparse, open forests of yellow pine, small animal life is scarce and daytime summer temperatures are unfavorably high. These conditions tend to restrict garter snakes to the vicinity of water, where animal life is more common, and the more abundant vegetation furnishes protection from high temperatures, as these snakes are strictly diurnal. The entire

range of the mountain garter snake except this northeastern portion is also occupied by snakes of the moccasin group (*couchii, hydrophila, hammondii*), which are aquatic in their habits. The absence of competition from these specialized aquatic forms in Lassen and Modoc counties may promote aquatic tendencies in the mountain garter snake there, which tends to fill the otherwise unoccupied aquatic ecologic niche.

The writer's observations on garter snakes in that region were made mainly at Ash Creek in northwestern Lassen County. There they were actually abundant and 25 were seen during an afternoon and morning spent hunting them, whereas four represents a maximum day's catch at other localities. At Ash Creek all were found within five feet of the water. One escaped by crawling under a boulder, but all others made for the water when opportunity offered. Usually they swam on the surface across the stream without diving. Others were taken under similar conditions at Rush Creek a few miles away. Series from Eagle Lake, Grasshopper Lake near Canby, and on the headwaters of the Pit River presumably were found concentrated in the vicinity of water, as those which contained food had eaten aquatic animals, either fishes or leeches.

Elsewhere in the range of the mountain garter snake, individuals were never found in such numbers, but possibly the difference was due to more even distribution over varying terrain with little concentration along water courses, rather than to any actual rarity.

Though it occurs on common ground with the moccasin garter snake in the Upper Sonoran and Transition life zones of the Sierra Nevada, the present form occurs also at higher elevations above the altitudinal range of the moccasin, hence the name "mountain garter snake". The difference in altitudinal range is correlated with differing ecologic preferences, but not necessarily with physiological differences in ability to resist low temperatures. In mountain streams of the high Sierra Nevada, water temperatures are so low that a snake of aquatic habits would be constantly chilled to a state of sluggishness or inactivity and would be badly handicapped in its attempts to capture prey or escape from enemies. Thus, habitat conditions in the high Sierra are unfavorable to aquatic forms such as the moccasin garter snake, but the more terrestrial habits of the mountain garter snake permit it to take immediate advantage of rising air temperatures whenever they become sufficiently high for it to forage.

The mountain garter snake appears to be versatile, to a certain degree, in its feeding habits in adaptation to local conditions, but it feeds mainly on terrestrial kinds of animals, some of relatively large size in proportion to the size of the snake. Fish may be eaten occasionally, but obviously this form is not adapted to foraging in swift water. Most of the fish eaten are caught in shallow water, frequently in drying pools of stream beds. Trout are sometimes eaten, but such predation is most apt to occur where they are concentrated in drying pools and cannot be considered serious. The mountain garter snake is mainly neutral or beneficial in the economic bearing of its feeding habits. Fish form only a small portion of its food; fish predation is mainly limited to a small part of the geographic range, and involves mostly or entirely species of no importance to man as game or food.

Coast Garter Snake *(Thamnophis ordinoides atratus)*

Diagnostic Characters

Size medium to small (22 to 31 inches in adults); dorsal stripe bright yellow, 1½ to 3 scale rows wide, contrasting with dark ground color; back between dorsal and lateral stripes dark gray or brown; lateral stripes dull yellow, or red, or entirely absent; chin yellow; iris uniformly greenish gray in southern part of range, dark brown with narrow yellow rim encircling pupil in snakes from farther north; scale rows on body 21 or 19 (one of these counts obtainable anywhere on anterior two-thirds of body); supralabials usually 8 on each side, occasionally reduced to 7; ventral surface often spotted with red.

Distribution

Coast counties of California, from northern Humboldt County south to the Santa Ynez River, Santa Barbara County. Mainly confined to the fog belt on seaward side of the immediate coast ranges. Intergrades to the eastward, in eastern Humboldt County, with the mountain garter snake by increase in number of ventral scales, and by disappearance of red from the coloration. In northwestern Humboldt County and Del Norte County intergrades with the red-striped garter snake through reduction in numbers of ventral scales and in numbers of scale rows and labial scales, reduction in size, and through change in color of dorsal stripe.

Habits

Van Denburgh wrote (1923, p. 823) that this snake is usually found near water but seldom in it. Grinnell and Camp (1917, p. 180) defined the habitat of *Thamnophis ordinoides ordinoides* (referring chiefly to the present form) as "dense vegetation along streams and marshy ground". Habitat data compiled by the writer from his own observations and from field notes of collectors for the Museum of Vertebrate Zoology fully bear out these statements. Specific conditions under which individuals were found are summarized in the following paragraphs:

Dry, brushy ridge in manzanita, huckleberry, tan oak, and coyote brush association (W. P. Taylor, MS, Gualala, Mendocino County, July 4, 1913); *Ceanothus* brush area burned over six years before (C. L. Camp, MS, near Cazadero, Sonoma County, June 21, 1913); among tules (H. G. White, MS, near Morro, San Luis Obispo County); 10 feet from edge of Wildcat Canyon Dam (R. E. Smith, Contra Costa County, October 18, 1935). During the spring of 1936 my zoology students recorded these snakes found in the vicinity of Berkeley, Alameda County, in the following situations: moist swale on grassy hillside about 100 yards from creek; in grass; in grass 40 feet from water at side of reservoir; near stream; south-facing slope on wet ground; in hole on open grassy hillside; on slope in meadow; in grass on south-facing slope; in nearly dry creek; south-facing grassy slope; a few feet from stream.

At Prairie Creek, Humboldt County, in July, about 16 were seen at the edges of grassy fields; they attempted to escape by darting over

the undercut bank of the creek and hiding among the tangled roots and bushes there, but none entered the water.

At Bluff Creek near Weitchpec, Humboldt County, in July, two found were on the road 50 and 100 feet from the stream. At the east fork of Willow Creek, in July, those collected were found: dead on road; on steep hillside 100 feet from creek; in alder bush 10 feet from creek; swimming on surface in shallow water at edge of creek; among mossy rocks in heavily shaded spot five feet from creek. This was in humid Transition Life Zone with a plant association of Douglas fir, tan oak, broadleaf maple, madrone, Port Orford cedar, dogwood and blackberry. At Redwood Creek, Humboldt County, in July, one was found crawling among rocks and brush five feet from the edge of the water. One found at Bull Creek, Humboldt County, in July, was on the road 150 feet from the stream in second growth redwood association. Near Elk Creek, Mendocino County, in June, on a gently sloping, south-facing hillside with dense cover of tall dry grass, thistles and blackberry vines, five were found. At Lake Merced, San Francisco, in September, 24 were found on damp, weedy ground, all within 75 feet of the lake, but none was nearer than 10 feet to the edge of the water. In Marin County during March, one found near San Geronimo was dead on the highway about 200 feet from the nearest water, a small creek; near Ross two were found on a steep hillside 100 yards from water, in live oak, madrone and redwood association. In Strawberry Canyon, Alameda County, one was found 30 feet from the dry creek bed, in dense chaparral; one found in April was 50 feet from the creek in dense chaparral on the north-facing slope, another was 200 yards from the canyon bottom in a ravine 10 feet from a slight trickle of water. In Mendocino County one found in June, 75 feet from the Russian River, was crossing a road; at Rattlesnake Creek southeast of Cummings, in June, one was found beneath alders 15 feet from the stream, another was dead on the road at least 50 feet from the creek; of two found at Seward Creek in August, one crawled into a tangle of roots overhanging the water in escaping, another darted down the bank, dove, and hid under water among dead leaves on the bottom. Of three taken in July at Cobbs, Van Duzen River, Humboldt County, one was beneath alders 10 feet from a seepage pool and about 100 feet from the river; another was five feet from the river on a steep bank heavily shaded by alders; the third was 50 feet from the river on damp mossy ground beneath hazel and alders.

It is evident from habitat and feeding data that the coast garter snake is mainly terrestrial in its habits, that small terrestrial animals, mainly slugs, salamanders, worms and lizards, comprise most of its food. The kinds of animals preyed upon are small, secretive and inactive forms which occur in damp places. The rarity of occasions on which this snake has been found in the water and the frequency with which it has been found distances from the water show that it is primarily a meadow and thicket-inhabiting subspecies. Fish predation is therefore exceptional. This snake has not been known to prey upon trout or other game fishes, and is largely neutral or beneficial as regards the economic bearing of its feeding habits.

Red-striped Garter Snake *(Thamnophis ordinoides ordinoides)*

Diagnostic Characters

Size small (length 13 to 30 inches in adults); dorsal stripe various shades of red, yellow or orange, usually well developed, sometimes faint or nearly absent; lateral stripe pale, yellowish gray, or occasionally absent; dorsolateral areas between dorsal and lateral stripes chestnut or grayish brown, occasionally almost black; ventral plates of body fewer than 155, of tail fewer than 85 pairs; ventral surface often spotted with bright red; supralabials 7, 7; infralabials usually 8 or 9 on each side; head narrow, not distinct from neck, with relatively small eyes; scale rows on body 19 (on anterior part of body only) or 17.

Distribution

In California confined to Del Norte County, extreme northern Humboldt County, and western Siskiyou County; occurs northward between Cascade Range and seacoast through Oregon, Washington, and British Columbia. Intergrades with the coast garter snake in the region around the mouth of the Klamath River, but does not intergrade with any other form. Throughout the California portion of its range occasional individuals occur which closely resemble the coast garter snake in their characters.

The southern population, to which the California representatives of this subspecies belong, is characterized by a reddish stripe and brownish ground color in the coastal region. Farther from the coast these snakes are less common, and tend to have a darker ground color and a more yellowish dorsal stripe.

Habits

Only three of the California specimens examined contained food—one slug each in two from Wilson Creek and Gasquet, and one earthworm in one from Crescent City. These items seem to be typical of the food items taken in other parts of the range: a total of 48 snakes contained food or were seen feeding, and the prey comprised 67 individual animals, all of terrestrial kinds, and, with one exception, forms of inactive and secretive habits. Thirty-two snakes had eaten slugs (average length $\frac{3}{4}$ inch), ten had eaten earthworms, ten had eaten plethodont salamanders *(Plethodon elongatus, P. dunni, Aneides ferreus)*, one had eaten a red-legged frog.

Field notes concerning the behavior and habitat of this snake were taken for more than 100 individuals at 20 different localities, mostly in southwestern Oregon. Many were found in dense coastal forests of tan oak and Douglas fir, but they were found in greater numbers in and around clearings, meadows and glades.

During the latter part of May, 1935, 80 were seen in the region around the mouth of Lobster Creek, Curry County, Oregon. Nearly all were on "benches" above the level of the creek and at the edge of the forest. No undisturbed individuals were seen in the water at this locality or elsewhere. They did not frequent open beaches and bare rocks along the edge of the water, though Oregon gray garter snakes, occurring in this same locality, were largely confined to this streamside habitat.

On several occasions, at places where the grass and brush grew up to the edge of the water, red-striped garter snakes were found there, affording opportunity to compare their escape reactions with those of the gray garter snake. Red-striped garter snakes invariably attempted to hide beneath objects on the ground. Individuals experimentally thrown into the stream swam briskly for the nearest point on shore, holding their heads high out of the water, and landed despite the observer's presence. They could hardly be driven back into the water, but usually drew back into a defensive position if retreat to shelter on the bank was cut off.

These observations indicate that aquatic tendencies common to most garter snakes are remarkably lacking in the present form, which is specialized for a terrestrial life amid dense vegetation.

It is obvious that the red-striped garter snake is not an enemy of fish, since it rarely enters the water voluntarily. In the economic bearing of its feeding habits it is almost totally beneficial, as it feeds mainly on foliage-destroying slugs. Snakes watched in the process of foraging kept their heads close to the ground and moved slowly along extremely circuitous routes, tending to follow depressions below the general level of the ground surface. Sometimes during the frequent pauses they would make lateral peering movements, but they seemed to be guided largely by tactile sense, perhaps also by smell. They were especially prone to investigate niches and crannies and to move beneath logs and other objects on the ground. Evidently the secretive animals which these snakes prey upon are found while they are inactive and in hiding, during the daytime. The snakes are strictly diurnal, and usually are not active on foggy days.

SUMMARY AND CONCLUSIONS.

In the foregoing account, the habits of ten different kinds of California garter snakes have been separately discussed. For each kind numerous specific instances of feeding, of field behavior, and of habitat preferences have been recorded. From these data, based upon published literature, unpublished field notes of trained observers, and the personal observations of the writer, it has been demonstrated that the several kinds of garter snakes all differ from each other in their habits. Some are exclusively terrestrial in their foraging, and others are almost entirely aquatic and hence use a different sort of food. Some may conflict with man's interest by preying upon trout and other fishes valued as food or game. Other kinds of snakes, though closely related to these potentially harmful kinds, are almost entirely beneficial in their economic bearing, since they prey upon animals which are detrimental to man's interest—vegetation-destroying slugs. Still others have no obvious economic importance, as they prey upon animals which are largely neutral and have neither direct value to man nor harmful habits—various small lizards, frogs, salamanders, worms and leeches.

The stream-inhabiting and fish-eating forms have in common certain characteristics which set them off from those forms typical of marsh, meadow or brushland habitats, and which seldom or never prey on fish. None of the typically stream-inhabiting forms has a bright yellow dorsal stripe, but the stripe may be narrow and faint or alto-

gether absent. In the southern California garter snake there is no dorsal stripe; in the moccasin garter snake, the dorsal stripe is faint and usually confined to the anterior part of the body; in the Oregon gray garter snake, the dorsal stripe is narrow and dull, often discontinuous on the anterior part of the body; in the wandering garter snake, the dorsal stripe is likewise faint and occasionally broken, though it extends the entire length of the body; in the giant garter snake the dorsal stripe is faint and may be nearly absent. These five comprise the aquatic members of the genus in California and are responsible for nearly all garter snake predation on fish in this State. It seems probable that their dull coloration may be adaptive in serving to conceal them in their relatively exposed streamside habitat, as they habitually bask on bare rocks at the edge of the water.

Brightly colored stripes are characteristic of the kinds which are primarily terrestrial in their habits. In the red-striped garter snake the dorsal stripe is red, orange or yellow, and highly conspicuous; in the coast garter snake and mountain garter snake, it is bright yellow, contrasting sharply with the dark ground color. The common garter snake also has a yellow dorsal stripe which is especially bright and sharply defined. All these snakes live mainly in grass or brush. Under such habitat conditions, the conspicuous longitudinal markings may have protective value in concealing motion. To the observer watching one in motion and partially concealed by screening vegetation, the section of the snake's body in sight appears to shrink rapidly and disappear before his eyes, but because of the longitudinal continuity of color there is no impression of motion. These brightly striped snakes are mainly beneficial in their feeding habits, since they eat slugs, earthworms, plethodont salamanders, lizards, mice, and other terrestrial animals, but seldom take fish or other aquatic prey, even when such food sources are abundant.

TABLE 1

Relative frequency of predation on various types of prey by different kinds of garter snakes. For each kind of snake, percentages of total recorded food items made up by each kind of prey are shown. (Records based mainly on observations of the writer, but also upon publications and field notes of various competent observers. All available records are included, some of them for snakes taken outside of California.)

	Prey of snakes	Common garter snake	Wandering garter snake	Klamath garter snake	Oregon gray garter snake	Mocasin garter snake	Southern California garter snake	Mountain garter snake	Coast garter snake	Red-striped garter snake
Terrestrial	Slug	1.4	18.0					28.6	83.0	63.0
	Snail		8.7							
	Earthworm	23.6	8.1				1.9	3.0	.5	24.0
	Terrestrial salamander							1.0	1.5	12.0
	Frog (*Rana*)	6.9	1.7	4.0	3.9			5.0		1.0
	Toad (*Bufo, Scaphiopus*)	30.5	5.0			9.0	1.9	16.8		
	Tree toad	20.8				1.0	20.7	8.9		
	Lizard		3.0					8.9	3.0	
	Snake								1.0	
	Mouse		6.5					3.0	6.0	
	Brush rabbit								.5	
	Shrew							1.0		
	Bird		3.2					1.0	3.0	
Aquatic	Leech	4.0	13.5	20.0				8.9		
	Tadpole	10.0	17.7	4.0	53.2	62.0	66.1	1.0		
	Lamprey			12.0						
	Trout				9.7	23.0		1.0		
	Minnow, sucker	1.4	1.0	20.0	1.3	1.0		11.8		
	Sculpin		1.0	40.0	15.6				.5	
	Unidentified fish	1.4	7.6		10.4	2.0	7.5		1.0	
	Fish egg mass				2.0		1.9			
	Aquatic salamander		5.0		3.9	2.0				
	Number of snakes	48	69	20	96	44	27	49	59	48
	Total items recorded	72	185	25	139	133	53	101	186	67

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VALLEY QUAIL CENSUS METHODS AND POPULATIONS AT THE SAN JOAQUIN EXPERIMENTAL RANGE [1]

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One necessary prerequisite to the management of any game species is a knowledge of the population and of any trends it may exhibit toward change. Variations in populations or trends therein are of greatest significance but often are not pronounced enough to be noticed in general observation. Indications are that the numbers of California valley quail (*Lophortyx californica*) fluctuate considerably, but lack of data has made it obvious that some inventory technique is essential.

A method has been developed, evolving from other forms of surveys, for the annual census of valley quail on the San Joaquin Experimental range in Madera County, California, which appears suitable for this and other similar cover types. The area is located in the rolling foothills of the western Sierra Nevada. The open vegetation type is characterized by individual blue oaks or digger pines and small clumps of *Ceanothus*. Topography and cover allow easy travel by horse over the entire Range. (See Fig. 24.)

Plant and animal associations have been described by Talbot, Biswell and Hormay (1939) and by Glading (1938). Many California sportsmen consider such areas as ideal for quail hunting.

During February, 1935, members of the local staff, assisted by members of the Madera County Fish and Game Protective Association, counted the birds on sample strips of the Range. According to F. G. Renner, who took notes for the census, 12 men participated. The final figure arrived at was about 1,600 quail (one bird per 2.2 acres or 0.44 birds per acre), although estimates by various members of the party disagreed as to the accuracy of this figure. One observer estimated 2,500 to 3,000 birds on the Range, while another estimated 4,000.

In February, 1936, the resident staff sought to obtain a more accurate figure for the quail population of the Range as a whole, and with the suggestion of J. W. Nelson they developed the "horseback"

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[1] A branch of the California Forest and Range Experiment Station maintained by the Forest Service, U. S. Department of Agriculture, at Berkeley, California, in cooperation with the University of California.

The quail study is under the guidance of a committee composed of Tracy I. Storer, chairman, and J. T. Emlen, Jr., of the University of California College of Agriculture; E. E. Horn and H. S. Fitch of the U. S. Fish and Wildlife Service; Gordon H. True, Jr., of the California Division of Fish and Game; E. I. Kotok, M. W. Talbot, H. H. Biswell, and J. W. Nelson of the California Forest and Range Experiment Station, U. S. Forest Service; and F. P. Cronemiller and Ivan Sack of Region 5, U. S. Forest Service. Messrs. Storer, Horn and Cronemiller form a special technical advisory committee. Funds for the project are supplied by Region 5, U. S. Forest Service. The writer has been engaged by the Committee as a resident investigator at the San Joaquin Experimental Range. Additional help in various projects was obtained through the use of U. S. Forest Service Junior Assistants to Technicians and Civilian Conservation Corps enrollees for manual labor. Studies began in December, 1936, and are still in progress.

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FIG. 24. Portion of the San Joaquin Experimental Range, illustrating typical topography and cover of the area. Three horseback counters are shown to illustrate the method described in the text.

method. This has proved so effective that it is now employed whenever detailed counts over the entire Range or large portions of it are desired.

In this method, three men, mounted on horseback, ride in parallel courses slightly more than 200 feet apart, making 24 man-strips per lateral mile; each man watches and counts the quail seen on a strip only slightly more than 100 feet on each side of him. If vision is obscured by rocks or heavy brush, the riders "zig-zag" slightly in order to observe all possible game coverts. When the riders come to the end of their strips they pivot about on the outside man, so that he may guide them back accurately on a course parallel to and at the correct distance from the one he has just covered. Thus, if riders 1, 2 and 3 started out at the southwest corner of a large area, they would first ride in an easterly direction with No. 1 on the south and No. 3 at the north. Upon arriving at the east boundary, they wheel about No. 3 and he guides them on the return trip to the west boundary. The order would then be No. 3 at the south and No. 1 at the north. This procedure is repeated until the census area has been completely covered. Over some areas, because of irregularities in topography and boundaries, it may be necessary to depart slightly from the strictly parallel strips, but in any event an effort is made to cover all of the country within the census area. For satisfactory results, it is imperative that at least one and preferably all of the riders be thoroughly acquainted with the local terrain.

The center man (No. 2) acts as recorder. The number of birds in each covey and the exact location of the covey are entered on a topographic map which he carries. As the other riders see and count quail, they immediately indicate the number and location to the recorder. In many cases it is possible for two or all three riders to count a covey,

thus providing a more accurate result. Disagreements between observers as to the number of quail seen in a particular group are settled by accepting the count of the man best able to see the birds in question.

To avoid duplication of coveys flushing or running from a strip which is being counted to one not yet censused, the recorder indicates the direction of movement of such birds by an arrow on the map, and discounts any report of a similar group of birds at that site on the return trip. Where possible, an extra observer or two rides behind the counters to watch for birds that may flush onto the next strip. If the outside rider (next to the uncensused area) keeps slightly ahead of the other two and endeavors to flush new coveys back toward the other counters, the instances of birds crossing into uncounted territory are fewer.

While three counters have been found to be the most practical number to employ on a census in rolling country such as occurs at the Range, either two or four riders have been used in some cases. Four riders, while able to cover up to 1,000 acres a day, add somewhat to the difficulties of recording and keeping alignment. Two riders can census about 500 acres a day, whereas the optimum number of three can count the birds on 750 acres during an eight-hour day.

Best results are obtained when the birds are grouped in definite coveys. At the Range this means from late September through early March. Counts are unsatisfactory on days which are very hot or windy, or when it is raining. If the time of the year and weather conditions are right, this method is believed to be about 90 per cent accu-

TABLE 1

Summary of the Annual Censuses of Valley Quail on the San Joaquin Experimental Range, 1935 to 1940

Area	Date	Acres	Number of Quail	Number of Coveys	Birds per Covey	Birds per Acre
"Original Range"	1935, Feb. 27	3,600	[a]1,600			[b]0.44
	1936, Feb. 27–Mar. 4	3,600	1,637	68	24.0	0.45
	1937, Feb. 24–Mar. 2	3,600	2,123	99	21.4	0.59
	1938, Mar. 9–Mar. 17	3,600	1,545	86	17.9	0.43
	1939, Mar. 13–Mar. 17	3,412	1,293	103	12.5	0.38
	1940, Mar. 6–Mar. 10	3,412	873	90	9.7	0.26
"New Purchase Area"	1938, Mar. 18–Mar. 22	1,078	424	36	11.7	0.39
	1939, Mar. 18–Mar. 21	1,248	586	52	11.2	0.47
	1940, Mar. 11–Mar. 12	1,248	481	43	11.2	0.45

[a] Estimated.
[b] Sample strip count covering only a fraction of the range was employed in 1935.

rate for the Range as a whole. Repeated checks on small areas have shown that the "horseback" method gives an accurate, usable count, and at the same time makes it possible to cover a relatively large area with a minimum of personnel.

This method can only be employed satisfactorily where the cover is not too dense; the general character of the topography and cover at the San Joaquin Experimental Range where it has been used is shown in figure 24. The horseback census is not applicable to areas of heavy brush or uniform, tall grass. It is particularly adapted to use with valley quail, because these birds have the habit of flushing or running when approached as close as 25 or 30 yards by a man on horseback. Use of a pointing dog for counting valley quail has been tried on several occasions over small areas, but without success. The "pointing dog" method is successful on other species of upland game which tend to "freeze," such as pheasants and bobwhite (Wight, 1930; Bennett and Hendrickson, 1938).

The presence of a Cooper hawk in the vicinity of a covey will cause the quail to "freeze" and make it necessary to ride much closer to birds so frightened before they will flush. Concentrations of foraging Cooper hawks over a census area will result in observers missing many such "frozen" coveys.

Five annual counts have been made by the "horseback" method. The results of all censuses are summarized in table 1.[2] Figure 26 illustrates the distribution of coveys over the Range in 1939.

[2] The services of a WPA employee in assisting in some of these counts is hereby acknowledged.

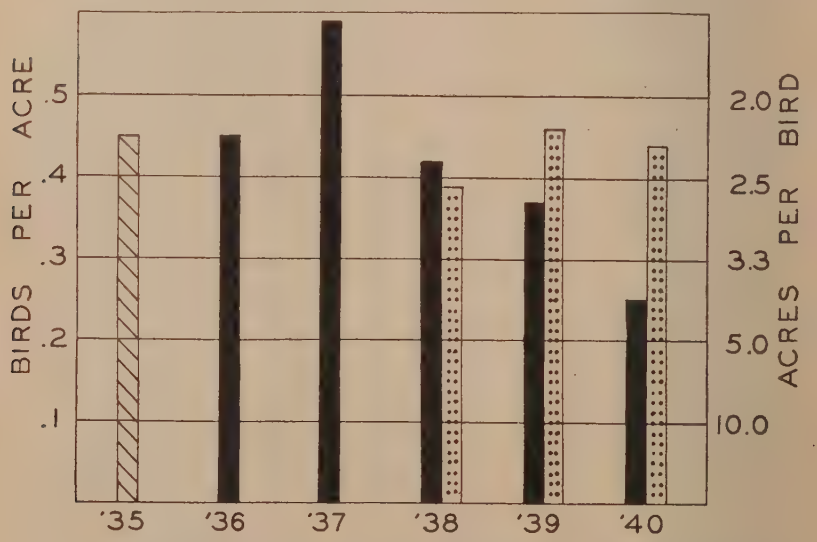

FIG. 25. Population trends in the valley quail at the San Joaquin Experimental Range. The hatched bar represents the "sample strip" method counts made in 1935. The solid bars represent "horseback" method counts over the original Range; and the dotted bars are "horseback" method counts over the new purchase area.

Just prior to the 1938 census, 1,078 acres of additional land were acquired to the north and west of the original Range. This area was counted immediately after the census of the original Range. In 1939, the construction of a new highway across the northwest corner of the original Range caused an area of roughly 170 acres from the original tract to be incorporated in the "new purchase," making the area to the north and west of the new road total 1,248 acres for the 1939 and 1940 counts.

In evaluating the census figures for the two areas, it should be borne in mind that the new purchase area had been hunted over to and

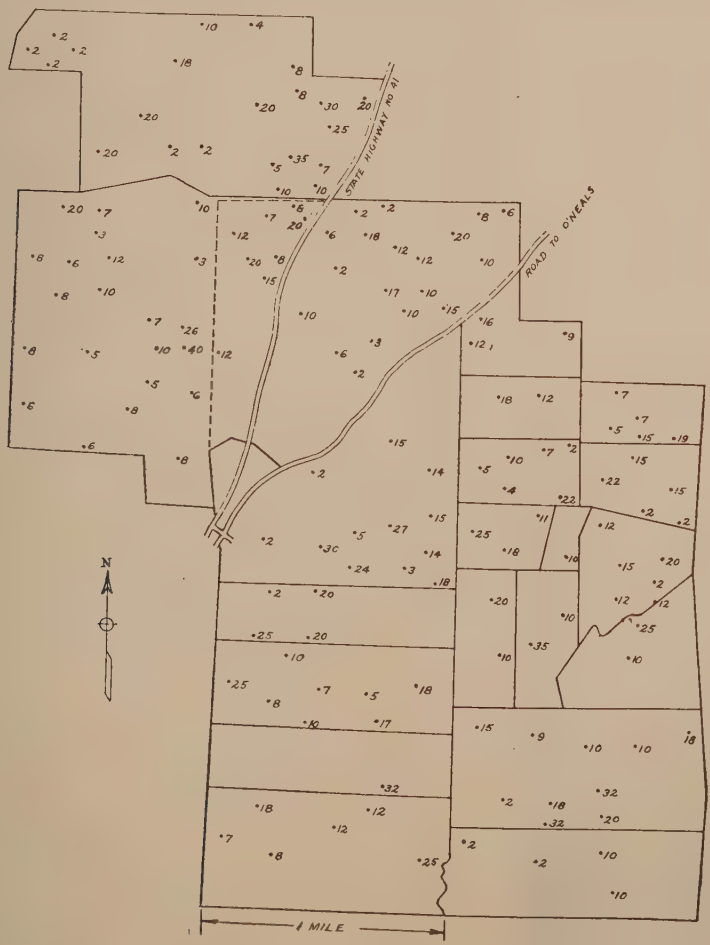

FIG. 26. Map of San Joaquin Experimental Range, showing location and size of coveys of valley quail in March, 1939. Solid lines represent pasture fences. The dotted line indicates the old west and north boundaries of the original Range. The area lying between Highway 41 and the dotted line was included in the original Range for the 1938 census, but was with the new purchase area for the 1939 and 1940 counts.

including the season of 1937, whereas no hunting was allowed on the original Range after the open season of 1933. Since the start of intensive quail study in December, 1936, an average of 10 quail per month has been removed from the Range for food analyses. In November and December of 1938 and 1939, an experimental hunt was conducted over a portion of the original Range. In 1938, 136 birds were taken and there was a crippling loss of 57 birds. In 1939, 62 birds were taken and the additional crippling loss was 26 birds. These are not taken into account in the total census figures cited above for the corresponding following censuses taken in 1939 and 1940.

The data from the five annual horseback censuses suggest a progressive decline in average size of covey; this may be due partly to the relative dates of the various censuses. The five successive counts have been made at increasingly later dates in the season as viewed climatically and biologically with respect to the reproductive cycle of the quail. The smaller sizes of coveys recorded are thought to be due primarily to the process of covey dispersal which normally begins about the middle of March at the Range. In 1939, however, nests were discovered about two weeks earlier than in the previous two years. The 1940 nesting season was slightly earlier than that of 1939. These earlier nesting dates combined with the early cessation of spring rains in 1939, the mild winter of 1940, and the relatively advanced stage of the vegetation of both years indicated that the censuses of 1939 and 1940, although taken at a comparable chronologic date to that of 1938, were biologically later in the season as far as the mating cycle of the quail was concerned.

The fluctuations in population which are exhibited in table 1 and figure 25 are not of such magnitude as is shown by the ruffed grouse in eastern states (Leopold and Ball, 1931). They do, however, indicate that variations exist in the local valley quail population in successive years. Whether these changes signify any cyclic change in the local quail can only be determined by a much longer record.

The census method herein described, if used according to the precautions indicated, will serve in areas of suitable cover and topography as a yardstick for evaluating populations of valley quail prior to and during the application of management methods.

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"N. B. SCOFIELD": PROGRESS REPORT FOR 1940[1]

By H. C. Godsil
California State Fisheries Laboratory
Division of Fish and Game

The function of the research staff of the Bureau of Marine Fisheries is twofold. Its first assignment is to determine the proper rate of exploitation of our various marine fisheries. When this is known, it is then necessary to follow the trend of each fishery in order to safeguard its future. The latter task is to a large extent routine, whereas the former necessitates a great deal of investigative work, much of which must be done upon the fishing grounds. To facilitate the investigative work, the *N. B. Scofield* was built in 1938 and for the past two years this vessel has functioned as an integral and important part of the Division's fisheries laboratory. Built and used exclusively for this work she has, in the two years of operations, contributed immensely to our knowledge of the fisheries by extending the range of our investigations. In the past year, the *N. B. Scofield* traversed 17,648 miles, ranging from northern California to the Galapagos Islands on the Equator.

To obtain the maximum benefit from our research vessel, it is necessary to plan the work in close conjunction with the entire research program. For this purpose the most urgent aspects of each investigation are listed and an annual program drafted with the time of the *N. B. Scofield* allotted to the different fisheries or different areas in proportion to their importance. Such a program was formulated for the past year (1940), and it is a satisfaction to report that this program was successfully followed to completion. Each projected piece of work was accomplished. The credit for this goes in large part to the crew of the *N. B. Scofield,* and it is a pleasure to acknowledge our continued indebtedness to Captain Lars J. Weseth, Messrs. Ralph Dale, Paul Richmond, Peder Stockland, Harry Rouch, Merile Stewart, Robert MacDonald, Harry Peters, William Nyland, and to those persons who substituted for short periods. Successful fulfillment of the program could not have been accomplished without the wholehearted cooperation of the governments of the countries in whose waters the vessel operated. We should like to express our appreciation of the many courtesies shown us by representatives of the republics of Mexico, Ecuador and Costa Rica.

[1] Submitted for publication, February, 1941.

Tuna

In 1940 the *N. B. Scofield* made a protracted trip to the tuna fishing grounds. Every important fishing area was visited and samples of tuna obtained therefrom. The purpose of the trip was twofold: (1) the essential refrigeration program was carried to completion, and (2) a collection of both tuna and skipjack was made for the purpose of a comparative study of the populations.

The results of the refrigeration work emphasized the necessity for prompt handling of fish after capture, confirming the findings of the previous year. Furthermore, in a mimeographed report to the industry, we were able to inform the fishermen that storage temperatures should not exceed a maximum of 20° F. for the average length of the present trips. Maintenance of this temperature will enable the fishermen to deliver their loads in an acceptable condition, providing prompt chilling is practiced. However, the quality of the fish could be improved by lower temperatures, where these are practical. Other experiments indicated some deleterious effects after prolonged storage in brine and the advantages of air circulation in a dry, frozen load. The results accomplished will enable us to plan the next phase of this investigation.

All the material needed for comparison of the populations of tuna on the different grounds was collected on this trip and the laboratory work is now nearing completion. Whereas, it will require many weeks of careful work before definite conclusions may be drawn concerning the populations in the different grounds, we are able to state tentatively at this time that there is but a single species of yellowfin tuna in the entire eastern Pacific in so far as this has been investigated. This in itself is an important contribution to our knowledge. In the case of the skipjack, preliminary results indicate that the entire stock in the northern Pacific thus far investigated represents a single species. Our own material was compared directly with samples from Japanese and Hawaiian waters.

At the Galapagos Islands a single specimen of a hitherto undescribed species of tuna was taken. The existence of this species was known from occasional reports from tuna fishermen, but this was the first opportunity we have had to make an original examination. A second specimen was obtained subsequently through the courtesy and cooperation of a commercial fisherman, and these will be described in a forthcoming publication. The occurrence, distribution and abundance of this fish will be investigated as opportunity offers.

Sardines

The census of young sardines was continued in 1940, with the *N. B. Scofield* working from central California to the tip of Lower California. This work was initiated in 1938 when young sardines were considered of average abundance. The abundance in the fall of 1940 was estimated as 22 per cent of 1938. In 1940 about one-half of the young fish were found off the northern half of Lower California, one-fourth in southern California waters and one-fourth in central California.

FIG. 27. Sardine fishing in Magdalena Bay, Lower California. The power launch in the foreground keeps the skiff out of the net as the men pull in the wings. The light lampara nets are hauled from the skiff whereas the heavier purse seine is fished from the *N. B. Scofield* itself. These nets are used for taking sardines in the young fish survey and for tagging as well as for catching tuna bait. Photograph by Merile Stewart.

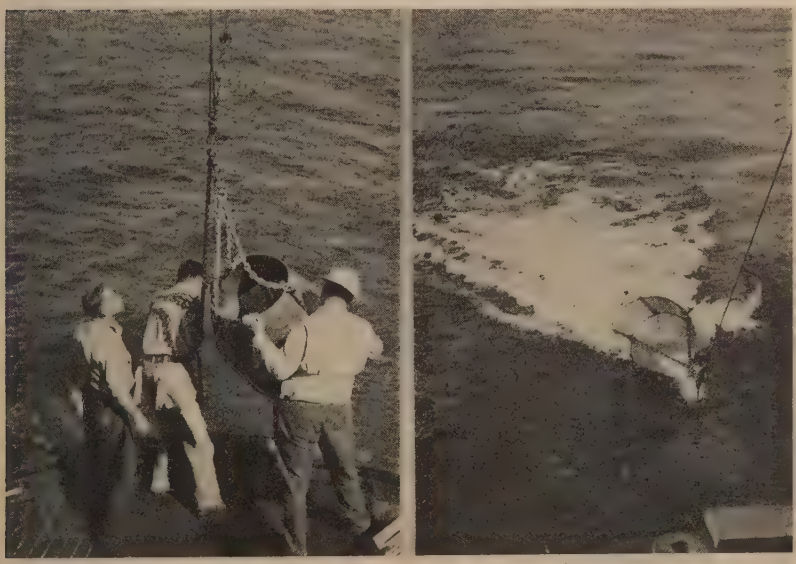

FIG. 28. Left, lowering metal tow net at the start of a haul. Right, the net breaks the surface at the end of the haul. Photographs by Merile Stewart.

This annual census makes possible an estimate of the amount that each year-class of sardines will contribute to the fishery one to three seasons later.

In January and February, 1940, sardine eggs and larvae were collected in the Gulf of California and maturing adult fish were taken. This constituted an extension of the known spawning grounds for the sardine. This material has contributed to the study of population differences along the Pacific coast of North America.

Using the *N. B. Scofield,* 7,600 sardines were tagged in Mexican waters during 1940. These taggings are a continuation of similar work done in 1939, which has yielded returns in the southern California fishery during the 1940-1941 sardine season. Sardine tagging in Mexican waters supplements the general sardine program carried out in California waters and greatly furthers the study of sardine migrations.

Mackerel

The mackerel investigation along the coast of Lower California was carried out from the *N. B. Scofield* during 1940. Tow net hauls for eggs and larvae were made along the west coast of the peninsula and in the Gulf of California. Larvae were taken as far up the Gulf as Pulpito Point, about 240 miles from the entrance. Samples of adult mackerel were taken in the Gulf to determine if they are part of the same population which is taken in California. More material is needed before this point can be settled.

FIG. 29. Searching a plankton haul for fish eggs and larvae aboard the *N. B. Scofield.* Photograph by Merile Stewart.

Along the west coast of Lower California, a total of 4,664 mackerel were tagged to aid in determining what part these fish play in the California fishery. Over 40 of these tagged fish had been recovered in southern California by March 1, 1941.

Flatfish

In 1940 an extensive survey of the stock of flatfish in northern California was conducted. The *N. B. Scofield* worked from San Francisco to the Oregon line, sampling all the important commercial grounds. This work revealed the age and size composition of the commercial species along the coast line, and the results will enable us to determine the condition of the fishery and to suggest any regulatory measures needed. Scales were taken from sampled fish and will be used in determining the relative age composition of the catch.

In addition, approximately 5,000 fish were tagged and liberated at selected points along this coast line. In the case of the flatfish, the tagging program has already yielded valuable results and the work conducted this past season was designed to confirm and extend these findings.

Attempts were made in the course of this trip to explore grounds in deeper offshore waters. These were not very successful, but the experience gained will be used in future work.

* * * * * * * * * *

Finally, in addition to these major problems, lesser ones were tackled as opportunity offered. Throughout the year, collections of local and Lower California fish were made and identified to aid in the study of the distribution of larvae and of the commercially important species. Water temperatures were taken regularly on all trips and these are used in correlation with the seasonal runs of fish. All in all, the *N. B. Scofield* contributed largely to a busy and productive year and continued a record of which all are justly proud.

FIRST RECORD OF THE HYBRID FLOUNDER, *Inopsetta ischyra*, FROM CALIFORNIA [1]

By Earl Stannard Herald
Natural History Museum
Stanford University, California

A study of some of the California flatfishes in the Stanford University collections has recently brought to light a unique specimen which upon comparison with the published descriptions and with a specimen of *Inopsetta ischyra* from Puget Sound (Stanford 23738) may undoubtedly be referred to that species. This individual, taken off San Francisco about November 11, 1936, was discovered in the fish market by G. H. Clark of the California Division of Fish and Game, and subsequently presented to the Museum (Stanford 34964).

Inopsetta ischyra was first described by Jordan and Gilbert (1880) from four specimens taken in Puget Sound. From that date until 1927 no additional specimens were known. At that time Villadolid published a paper in which he announced his rediscovery of the species, the material consisting of three specimens which he had collected, two from the Seattle fish markets and the third from Holmes Harbor, Puget Sound. He also pointed out that the figure used to illustrate *Inopsetta* in Jordan and Evermann's "Fishes of North and Middle America" (p. 2641, fig. 927) was actually a figure of *Lepidopsetta bilineata*. However, it remained for Norman (1934, p. 376) to suggest that *Inopsetta* might be a hybrid, perhaps between the broad-fin sole *(Lepidopsetta bilineata)* and the starry flounder *(Platichthys stellatus)*.

Schultz and Smith (1936) finally settled the question as to the status of *I. ischyra* after they had collected twelve specimens from the vicinity of Puget Sound. By carefully comparing these specimens with the other species in the Sound region, it was decided *I. ischyra*, if a hybrid, must represent a cross between *Platichthys stellatus* and *Parophrys vetulus*, the pointed-nosed sole.

If this hypothesis is correct, then *I. ischyra* should also be found at other localities where both parent species are present. Both species are abundant in California; however, until this date, no specimens of *I. ischyra* have been recorded from the State.

Schultz and Smith state that this hybrid flounder is well known to the fishermen of the Sound who regard it as a hybrid between the starry flounder and some other species. But in California waters, *I. ischyra* is a rarity, for according to Clark only about four specimens of this hybrid have ever been noticed in the San Francisco area by the fish butchers or by the fisheries research staff of the California Division of Fish and Game.

As seen from the figure, *I. ischyra* has the pigmented areas in the fins as does *P. stellatus*, but it lacks the star-shaped tubercles of this

[1] Submitted for publication, December, 1940.

latter species and has instead ctenoid scales fairly evenly distributed over the body. Usually the pigmented areas of the fins are much lighter than is typical of *P. stellatus*.

From the illustrations it will be noted that a part of the lateral line system is asymmetrical in that on the blind side (lower left illustration) there is a lateral line branch extending in an arc ventro-caudad

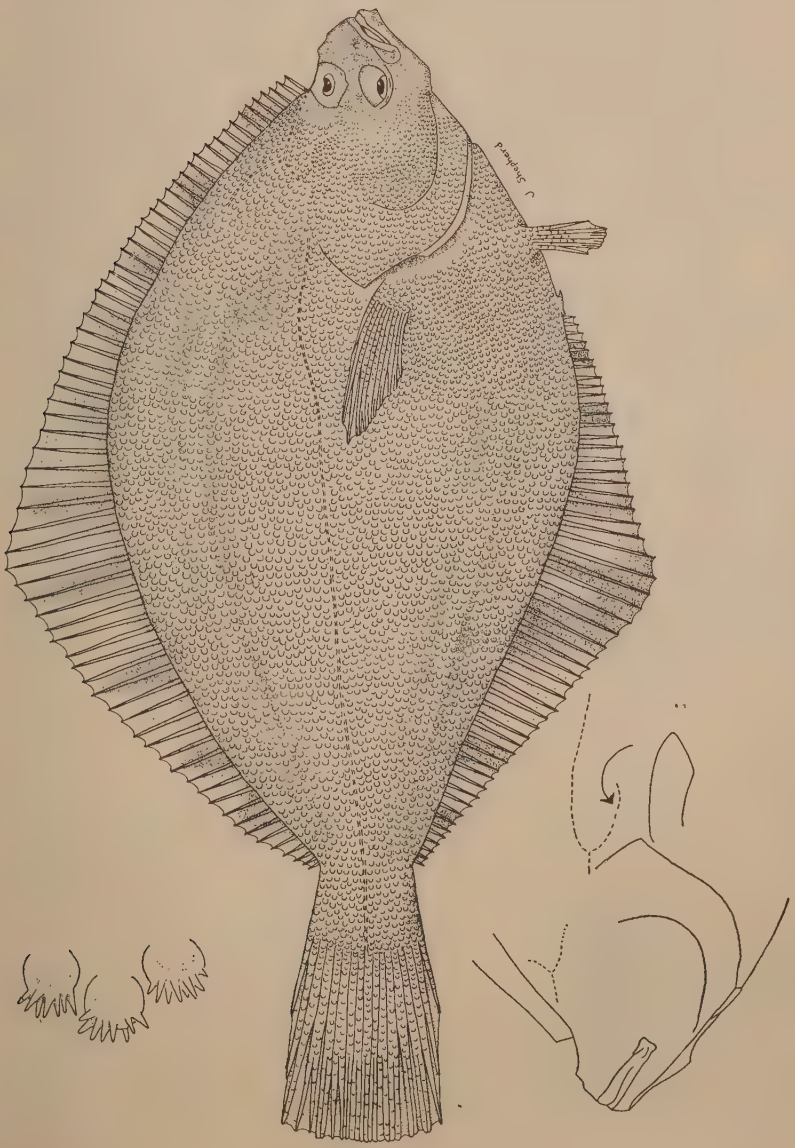

FIG. 30. *Inopsetta ischyra*, taken off San Francisco, California; Stanford catalog no. 34964. Upper left, three enlarged scales; lower left, outline drawing of blind side. J. Shepherd, del.

from the angle of the opercle. This branch is not present on the eyed side, nor is it present on either side of any specimen examined from a large series of both *P. vetulus* and *P. stellatus*. Dr. Schultz has very kindly examined the specimens of *Inopsetta* in the U. S. National Museum. He finds only one which has not been dissected on the blind side; again, the auxiliary branch is not present on this individual. It is probable that this structure on the San Francisco *Inopsetta* is an anomalous condition.

In presenting measurements and counts of the specimen of *I. ischyra* from San Francisco, it was thought advisable to include comparisons with the parent species and with other known specimens of *ischyra*. These three columns of data are taken from Schultz and Smith (1936). Each column gives the range of variation, followed by the mean value in parentheses; no series from which measurements and counts were taken was composed of fewer than 11 specimens; measurements are expressed as thousandths of the standard length.

TABLE 1

Comparison of *Parophrys vetulus*, *Platichthys stellatus*, and *Inopsetta ischyra*

	Pacific Coast *Parophrys vetulus*	Puget Sound *Inopsetta ischyra*	San Francisco *Inopsetta ischyra*	Pacific Coast *Platichthys stellatus*
Dorsal Rays (last single)	72- 92(80.96)	68- 77(72.08)	70	52- 65(58.54)
Anal Rays (last single)	54- 70(61.27)	50- 57(53.08)	54	38- 64(42.18)
Pectoral Rays	11- 13(11.65)	11- 13(11.26)	11	10- 12(11.05)
Vertebrae (hypural excluded)	42- 44(43.21)	38- 40(39.13)	39	34- 36(35.31)
Gill-rakers (above angle)	4- 6(4.80)	4- 6(5.08)	6	3- 5(3.95)
Gill-rakers (below angle)	11- 13(11.80)	9- 10(9.58)	11	6- 8(7.75)
Scale Rows Crossing Lateral Line	89-103(95.50)	76- 86(82.40)	85	58- 70(62.26)
Head Length	267-301(282.5)	285-317(294.7)	289	284-321(304.1)
Snout Length	56- 69(60.60)	52- 71(58.9)	53	56- 73(65.6)
Greatest Depth of Body	353-399(379.2)	447-505(466.7)	497	459-529(496.0)
Snout to Pelvic Fin Insertion	271-297(281.8)	283-328(294.4)	294	285-361(307.4)
Least Depth of Caudal Peduncle	77- 97(86.8)	89-108(97.1)	97	87-109(99.2)
Length of Caudal Peduncle	97-124(107.7)	94-126(108.8)	91	100-156(129.5)
Bony Interorbital Width	5- 12(8.6)	7- 12(9.9)	10	8- 15(11.6)
Height of Arch of Lateral Line	3- 17(11.0)	9- 23(14.4)	22	17- 40(22.3)
Length Accessory Branch of Lateral Line	146-252(186.6)	15-102(61.5)	82	(Lacking arch)

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Editorials and Notes

TWENTY-FIVE YEARS AGO IN "CALIFORNIA FISH AND GAME"

Highlighting the April, 1916, issue of "California Fish and Game" was an article on the shad fishery of California by H. B. Nidever. This article described the introduction of shad to California waters and the remarkable success of the project. Within a few years of the first plant, which was made in 1871, shad had become numerous enough to support a commercial fishery. At first these fish commanded a high price in the local markets but as the supply increased the price and demand dropped. Nidever and the writers of several short notes and editorials along the same lines called attention to the fine food qualities of the shad and urged greater utilization of the resource which was virtually going to waste. A number of excellent recipes for cooking shad and full instructions on the removal of bones were given. Much the same situation holds today and shad still constitutes a neglected resource which is capable of providing a great deal of excellent and inexpensive food. As in 1916 the world is today torn by war and no source of food supply should be overlooked. There will be efforts made in the name of "national defense" to relax restrictions on the taking of our more popular fish which are already sadly depleted. In the long run our national economy will be better served by retaining present conservation measures for our over-fished species and by urging greater utilization of less popular but equally wholesome fish such as the shad.

By 1916 the grizzly bear was rather generally regarded to be extinct in California but persistent rumors still told of grizzlies in various parts of the State. One such rumor when run down proved to be an exceptionally large black bear, as recounted by Joseph Dixon. It was later shown (California Fish and Game, vol. 25, pp. 237-244), that grizzlies did exist in California as late as 1922, and even now we still hear rumors of grizzlies in the southern Sierra Nevada.. Perhaps the animal which adorns our State seal yet lives.

Barton Warren Evermann presented a second article on the distribution of elk from the San Joaquin Valley to various parts of the State. In 1914 and 1915 a total of 146 elk was distributed, leaving between 350 and 400 in the Kern County herd. Of the number moved, 25 died, but at least three fawns were born in 1915, so that about 124 were still alive in 1916.

A firsthand account of sea otter hunting in the 1880's was contributed by Chase Littlejohn. This article gives a resume of the rise and fall of the sea otter trade and describes the habits of these interesting fur bearers.

A number of short notes on various subjects rounded out the April, 1916, issue. To me, nothing is so fascinating as reading these old notes on wildlife conditions with their wealth of interesting and important information. They will always be valuable references.—*Richard S. Croker, Editor, California Fish and Game.*

RESULTS OF THE 1940 PISMO CLAM CENSUS

Staff members of the California State Fisheries Laboratory took the annual census of Pismo clams *(Tivela stultorum)* at Pismo Beach on November 27-29, 1940. This yearly count provides a measure of the clam population, indicating the size of the set of the previous summer as well as the survival from year to year of the older age-groups. It gives a measure of the number of clams of spawning age and of legal size as well as information as to the probable picture for the future.

The 1940 census showed first that the year's set was very small, and further that one age-group (clams now five years old) makes up slightly over one-third of the present population. This is the third successive neglible set, which means that for the next several years there will be very few clams reaching maturity, to say nothing of legal size.

There have been but three good sets in recent years—those of 1931, 1935 and 1937. The 1937 set has suffered a high mortality, and the 1931 set is now represented only by a few individuals in the closed area. Meanwhile, the only numerous group—survivors of the 1935 set—is now reaching legal size and is being removed, particularly from the open area. This means that while mature clams are momentarily fairly abundant, it is only a matter of time before diggers will have taken the bulk of them. The extent to which removal by diggers already affects this group can be shown by these figures; approximately 19 per cent of the original set survives in the closed area, but only 9 per cent remains in the area open to digging.

The actual number of clams found in 1940 was the smallest since 1928. In the intervening time, only two years (1934 and 1939) showed a scarcity approaching the 1940 figure. Although the total number of clams of all sizes dropped about 21 per cent from the preceding census, the actual number of mature clams on the entire beach in 1940 was about the same as in 1939, due to a good survival in the closed area. However, in the open area, the number decreased in 1940 because of the removal of the five-year-olds and the lack of replacements by younger clams.

In the closed area, the total is up over the past two years, though still only about half that of the best years, 1935 to 1937. Mature clams make up 81.4 per cent of the total, while some 32 per cent of the total are five-year-olds. However, even with the small number of young clams there, the picture is satisfactory, providing that poaching is held to a minimum and if a good set occurs within a year or two.

In the open area, a definite decrease in numbers seems inevitable. With the limited numbers of young clams now present, little in the way of additions to the older and legal groups may be expected for several years. The five-year group made up almost 35 per cent of the total found, and as stated, is showing the effect of digging and will soon be removed. The best we can hope for is a good set in 1941, which will at least give some promise of relative abundance for the future.—*Phil M. Roedel, California State Fisheries Laboratory, Division of Fish and Game, January 14, 1941.*

BLACK BRANT IN LOWER CALIFORNIA, FEBRUARY, 1941

For the past eleven years, James Moffitt of the California Academy of Sciences has conducted an annual census of the black brant *(Branta bernicla nigricans)* wintering in California. In 1935, 1938 and 1940, circumstances permitted an additional count at San Quentin Bay, Lower California, at about the time of the corresponding California censuses. The Bay is located about 180 miles south of San Diego.

The research vessel *N. B. Scofield* of the California Division of Fish and Game spent several days in the vicinity of San Quentin during February, 1941, while making routine fisheries investigations, and it proved possible for the writer, assisted by J. G. Carlisle, Jr., and Paul Richmond, to survey the Bay on the morning of February 2. In all, 1155 brant were counted, of which 230 were in the east arm and 925 in the west. We could not visit the upper portion of the east arm, but we were able to scan most of it with field glasses. Few birds of any sort were to be seen; however, it seems probable that some brant were there. Therefore, our total count of 1155 is a minimum. We had no trouble with birds crossing back and forth between counted and uncounted areas; flights were, fortunately, made almost entirely in the same direction. Hence we feel that the total obtained is reasonably accurate for the area covered.

On February 3, 1941, we saw one flock of 16 birds near Sacramento Reef, some forty miles below San Quentin, and another of about 100 brant, twenty miles farther south. No others were noted in the course of the trip which extended into the Gulf of California.—*Phil M. Roedel, California State Fisheries Laboratory, Division of Fish and Game, March 7, 1941.*

Reviews

California's Natural Wealth: A Conservation Guide for Secondary Schools

California State Department of Education. Bulletin, Vol. 9, No. 4, December, 1940, 124 pp., illus.

The need for conservation education in public schools is realized by all educators and conservationists although there is some disagreement as to how the subject can be best presented to the students. Recently the trend has been toward integrating nature study and conservation with other subjects rather than to add specific courses. In many States, active programs are under way in which conservation policies and practices are made real to the pupils by means of including information and work projects on natural resources in various courses. The results of conservation education are well worth the effort as the school children are the potential conservers or despoilers of our resources.

California schools have included nature study and conservation study in their curricula for years but now these subjects are being enlarged and made more vital. The State Department of Education has made a real step forward with its publication of the handbook *California's Natural Wealth.* This bulletin, which was prepared under the direction of the California Conservation Council, is intended for the use of secondary school teachers and pupils. It commences with a brief description of California's natural resources, which is followed by a summary of the meaning and necessity for conservation. Subsequent chapters present the various natural resources of the State in detail: water, soil, native flora, forests, wildlife, scenic areas, and mineral resources. Each chapter includes a comprehensive reading list. The final chapter discusses conservation in the school curriculum. It is recommended that conservation study should be made a part of regular courses on other subjects rather than be set up as something special. Suggested courses in which conservation studies could be integrated are: general science, biology, chemistry, physics, health and safety, social science, literature, writing, public speaking, mathematics, arts, and home economics. It is stressed that nature can not be studied in the classroom, and field trips, experiments and audiovisual aids are recommended.

The book is well written and should prove useful to teachers and pupils alike. The descriptions of the natural wealth of the State are uniformly good. A few more illustrations would have added to the booklet.—*Richard S. Croker, Editor, California Fish and Game.*

Fishing the Surf

By Raymond R. Camp. Boston, Little, Brown & Co., 1941. 223 pp., illus. $2.00.

With the publication of *Fishing the Surf,* another is added to the rapidly growing list of excellent handbooks on ocean fishing. As the title indicates this book treats primarily with surf fishing, which is perhaps the fastest growing outdoor sport in the country. The author has fished the surf since he was a boy and can write with authority.

The first chapter, dealing with surf signs, should be of utmost value to the novice. In it directions are given for choosing the best part of a beach, and how to fish the reefs and holes. Following chapters discuss fishing methods for striped bass, weakfish, bluefish, channel bass, bonefish and other favorites of the alongshore fishermen. Considerable attention is given to Pacific Coast surf fishing but the major part of the book is devoted to the Atlantic Coast. In addition to describing surf fishing methods, the author treats bay fishing and offshore boat fishing for the various game fish commonly known as surf fish.

The final chapters offer advice on casting, selection of tackle and home rod making.

In the opinion of the reviewer, *Fishing the Surf* is a well balanced and useful handbook.—*Richard S. Croker, Editor, California Fish and Game.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1940, to December 31, 1940, of the 92d Fiscal Year

Revenue for Fish and Game Preservation Fund:		
License Revenue:		
1941 series—		
Angling	$166 00	
Fish party boat permits	8 00	
Game breeders	2 50	
Total 1941 series		$176 50
1940 series—		
Angling	$416,629 50	
Hunting	419,995 50	
Commercial hunting club	850 00	
Commercial hunting club operator	305 00	
Trapping	1,117 00	
Fish packers and wholesale shell fish dealers	860 00	
Deer tags	146,482 00	
Fish tags	1,904 00	
Game tags	429 99	
Market fisherman	42,380 00	
Less market fisherman, refund to ineligible licensee	—10 00	
Fishing party boat permits	176 00	
Fish breeders	50 00	
Game breeders	137 50	
Game management	170 00	
Game management tags	146 35	
Kelp licenses	20 00	
Total 1940 series		$1,031,642 84
1939 series (see previous statement)		15,571 50
Total licenses, 92d fiscal year		$1,047,390 84
Other revenue—		
Court fines	$23,278 84	
Deer meat permits	2,469 00	
Fish packers	183,407 58	
Kelp tax	290 72	
Lease of kelp beds	52 80	
Miscellaneous revenue	2,784 30	
Salmon packers	11,513 31	
Total other revenue		223,796 55
Total revenue, 92d fiscal year		$1,271,187 39
Prior year, 91st —		
1937 series	—$34 50	
1928 series	—3,626 68	
Fish packers	—260 92	
Total prior year, 91st fiscal year		—3,922 10
Grand total revenue all years, Fish and Game Preservation Fund		$1,267,265 29

STATEMENT OF EXPENDITURES

For the Period July 1, 1940, to December 31, 1940, of the Ninety-second Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Administration:					
Demolition of exposition exhibits	$126 00	$481 03	$216 18		$823 21
Education and public information	395 16	48 20	261 20	$263 68	968 24
Executive	672 03	155 01	2,432 71		3,259 75
Exhibits			1,250 00		1,250 00
Fish and game magazine		1,165 76			1,165 76
Library	1,050 00	18 64	74 34	85 01	1,227 99
Property inspection	1,553 41	28 94	143 14		1,725 49
General office	4,052 93	1,492 90	32,386 88	193 48	38,126 19
Total Administration	$7,849 53	$3,390 48	$36,764 45	$542 17	$48,546 63
Patrol and Law Enforcement:					
Cannery inspection	$13,222 17	$113 54	$1,277 62		$14,613 33
Executive	8,671 68	205 85	1,068 66	$8 00	9,984 19
General office	3,360 00	342 03	791 41	179 83	4,673 27
Junior patrol	2,010 00	131 14	300 09	450 78	2,892 01
Land patrol	120,772 47	16,597 34	32,146 77	23,213 54	192,730 12
Marine patrol	43,634 04	8,696 17	17,245 26	13,851 72	83,427 19
M. V. *Bluefin* galley		168 25	15 30		183 55
M.V. *N. B. Scofield* galley		—308 49	304 86		—3 63
Pollution patrol	6,382 00	1,092 89	2,277 86	98 30	9,851 05
Total Patrol and Law Enforcement	$198,052 36	$27,038 72	$55,457 83	$37,802 17	$318,351 08
Marine Fisheries:					
Central Valley water project study	$3,597 63	$518 15	$1,283 34	$43 70	$5,442 82
Executive	1,830 00	25 53	169 85		2,025 38
Field supervision	1,830 00	135 18	408 59		2,373 77
Fish cannery auditing			1,945 09		1,945 09
General office	5,782 90	201 24	248 28		6,232 42
Research and statistics	30,222 46	2,665 86	5,229 59	865 95	38,983 86
Total Marine Fisheries	$43,262 99	$3,545 96	$9,284 74	$909 65	$57,003 34
Fish Conservation:					
Biological survey	$6,513 33	$1,287 73	$710 48	$298 90	$8,810 44
Executive	3,683 01	126 08	757 19	621 74	5,188 02
Field supervision	1,780 00	206 69	369 81	10 48	2,366 98
Fish food unallocated		9,674 26	1,221 09		10,895 35
Fish planting	2,171 72	1,012 57	938 19	822 74	4,945 22
Fish rescue	6,742 96	978 93	1,961 42	18 23	9,701 54
General office	3,555 00	460 54	178 50	14 20	4,208 24
Pollution inspection	2,090 66	184 89	348 53	57 54	2,681 62
Statistical	1,180 00	275 16	543 32		1,998 48
Stream improvement			1 68		1 68
Structural maintenance	1,528 55	159 87	590 82		2,279 24
Alpine Hatchery	1,422 75	646 36	148 13	8 17	2,225 41
Arrowhead Lake Egg Collecting Station	3,240 32	818 09	501 19	3 59	4,563 19
Basin Creek Hatchery	2,440 64	206 78	227 88	8 59	2,883 89
Bear Lake Egg Collecting Station	160 00				160 00
Benbow Dam Experimental Station	790 00	5 67	7 00		802 67
Big Creek Hatchery		27 29	—35		26 94
Blue Lakes Egg Collecting Station		31 92			31 92
Bogus Creek Egg Collecting Station	361 28	14 00	18 50	7 90	401 68
Brookdale Hatchery	2,465 80	334 85	356 33	9 97	3,166 95
Burney Creek Hatchery	3,558 38	214 76	176 10		3,949 24
Central Valleys Hatchery	1,506 78	257 48	764 53	98 35	2,627 14
Copco Egg Collecting Station	559 35		85 00		644 35
Experimental Hatchery	490 00	7 21	30 25		527 46
Fall Creek Hatchery	2,867 53	465 66	132 69	63 97	3,529 85
Feather River Hatchery	2,520 00	963 22	277 13		3,760 35
Fern Creek Hatchery	1,000 01	160 00	516 62		1,676 63
Fillmore Experimental Station	1,298 71	316 05	318 61	3 59	1,936 96
Forest Home Hatchery	2,254 52	1,524 98	748 62		4,528 12
Fort Seward Hatchery	2,114 81	172 60	88 33	40 40	2,416 14
Heenan Lake Egg Collecting Station		85 17		5 05	90 22
Hot Creek Hatchery	3,340 96	1,664 36	496 62	15 16	5,517 10
Huntington Lake Hatchery	880 32	99 31	244 34		1,223 97
June Lake Egg Collecting Station	160 00				160 00
Kaweah Hatchery	2,365 81	460 78	520 14		3,346 73
Kern Hatchery	752 33	157 50	273 68	390 00	1,573 51
King Salmon Experimental Station		18 58	24 20		42 78
Kings River Hatchery	2,734 85	428 97	331 32		3,495 14
Kirman Lake Egg Collecting Station	393 04	25 86	74 01		492 91
Klamathon Egg Collecting Station	1,068 78	157 92	72 48		1,299 18
Lake Almanor Hatchery	3,454 20	379 26	216 07	78 53	4,128 06

STATEMENT OF EXPENDITURES

For the Period July 1, 1940, to December 31, 1940, of the Ninety-second Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued:					
Lake Eleanor Egg Collecting Station		$3 56		$5 34	$8 90
Little River Egg Collecting Station	$223 23	1 35			224 58
Little Walker Lake Egg Collecting Station	255 00				255 00
Mad River Egg Collecting Station	200 00	104 10		8 38	312 48
Madera Hatchery	290 00	126 89	$394 96		811 85
Mt. Shasta Hatchery	22,512 32	7,228 83	1,509 26	1,209 64	32,460 05
Mt. Tallac Hatchery	1,676 59	1,342 01	171 14		3,189 74
Mt. Whitney Hatchery	7,767 05	1,335 92	1,735 74	38 74	10,877 45
Prairie Creek Hatchery	3,372 67	459 24	528 86	4 30	4,365 07
Rearing Reservoir	516 13	320 81	209 01	48 60	1,094 55
Rush Creek Egg Collecting Station	347 81				347 81
San Lorenzo Egg Collecting Station		14 32			14 32
Scott Creek Egg Collecting Station	1,020 00	26 97	102 77	485 28	1,635 02
Sequoia Experimental Station	1,029 02	272 06	544 49		1,845 57
Shackleford Creek Egg Collecting Station			50 00		50 00
Shasta River Egg Collecting Station	430 33		6 90		437 23
Snow Mountain Egg Collecting Station	1,182 00	139 14	40 14		1,361 28
Tahoe Hatchery	4,025 50	1,069 60	529 06		5,624 16
Waddell Creek Station	870 00	84 87	32 63		987 50
Yosemite Hatchery	2,693 22	649 12	249 00	26 87	3,618 21
Yuba River Hatchery	1,990 00	66 43	93 52		2,149 95
Total Fish Conservation	$123,847 27	$37,256 57	$20,467 93	$4,404 25	$185,976 02
Engineering:					
Engineering	$6,448 51	$603 42	$1,762 17	$884 10	$9,698 20
Executive	2,280 00	223 39	391 92		2,895 31
Fish screens	679 20	244 52	58 60		982 32
General office	776 54	14 82	33 82	7 44	832 62
Total Engineering	$10,184 25	$1,086 15	$2,246 51	$891 54	$14,408 45
Game Conservation:					
Duck rescue	$600 00	$142 73	$772 04	$3 72	$1,518 49
Elk refuge	960 00	232 55	188 85		1,381 40
Executive	4,830 00	375 96	886 33	13 24	6,105 53
Game management	6,265 80	1,023 23	1,523 24	990 56	9,802 83
General office	1,827 32	31 79	1,079 70	196 53	3,135 34
Grey Lodge Refuge	2,600 00	341 35	12 81	25 32	2,979 48
Imperial Refuge	1,416 13	33 57	109 60		1,559 30
Los Banos Refuge	2,487 35	449 74	229 08	1,517 73	4,683 90
Predatory animal lion hunting	3,194 01	537 06	3,387 14	1,476 60	8,594 81
Predatory animal trapping	16,822 00	3,180 47	3,406 17	2,308 38	25,717 02
Refuge posting		50 86			50 86
Research	3,948 39	499 23	1,091 87	123 70	5,663 19
Statistics	1,067 05	19 78	450 38		1,537 21
Suisun Refuge	2,038 73	309 09	223 83	183 20	2,754 85
Winter feeding and salting of game		45 00			45 00
Total Game Conservation	$48,056 78	$7,272 41	$13,361 04	$6,838 98	$75,529 21
Game Farms:					
Executive	$1,920 00	$42 77	$236 22		$2,198 99
Game bird distribution—					
Los Serranos	960 00	201 99	648 65		1,810 64
Yountville	5,053 87	1,048 12	1,360 38		7,462 37
Game management	500 00	277 19	125 45	519 41	1,422 05
General office	551 93	6 93	7 85		566 71
Los Serranos boarding house			31 78		31 78
Los Serranos Game Farm	6,094 46	1,895 62	1,183 54	10 75	9,184 37
Yountville boarding house	356 72	107 08	63 26		527 06
Yountville Game Farm	6,724 30	2,644 70	952 21	919 87	11,241 08
Total Game Farms	$22,161 28	$6,224 40	$4,609 34	$1,450 03	$34,445 05
Licenses:					
Executive	$1,920 00	$71 79	$143 00		$2,134 79
General office	780 00	654 71	277 27	$131 68	1,843 66
License distribution	7,417 85	1,632 96	45,818 53	120 92	54,990 26
Total Licenses	$10,117 85	$2,359 46	$46,238 80	$252 60	$58,968 71

STATEMENT OF EXPENDITURES

For the Period July 1, 1940, to December 31, 1940, of the Ninety-second Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Other Current Expenses:					
Fish screens—all objects					$25,939 94
Stream improvements—					
Benbow fish ladder	$168 00		$47 00		215 00
Granlees fish ladder project		$33 82	12 00		45 82
Mad River Fishway	72 00		17 50		89 50
Snow Mountain Egg Collecting Station	319 20	27 45	27 50		374 15
Miscellaneous projects		51 60	1,017 12		1,068 72
Total Stream Improvements	$559 20	$112 87	$1,121 12		$1,793 19
Total other current expenses					27,733 13
Total operating expenses, 92d fiscal year					$820,961 62
Less maintenance deductions					5,246 49
Net total 92d fiscal year expenditures					$815,715 13
Prior year 91st fiscal year for support					56,334 71
Total operating expenditures, 91st and 92d fiscal years					$872,049 84
Additions and Betterments:					
Purchase of game refuges and public shooting grounds and C.I.E.					20,361 48
Prior year 91st fiscal year for purchase of game refuges and public shooting grounds, etc.					2,237 61
Total Additions and Betterments, 91st and 92d fiscal years					$22,599 09
Special Item:					
Game management—cooperation with Federal Government					$14,071 06
Contributions to Employees' Retirement System, 92d fiscal year					11,485 58
Total Expenditures, 91st and 92d fiscal years					$920,205 57
Prior Biennium:					
Prior year, 90th, for support, not closed					—$472 03
Prior year, 89th for support not closed					20 65
Total, prior biennium					—$451 38
Grand total, Fish and Game Preservation Fund					$919,754 19

SEIZURES OF FISH AND GAME

October, November, December, 1940

Fish:	
Abalones, green	15
Abalones, red	15
Barracuda	23
Bass	3
Bass, Black	7
Bass, Striped	49
Carp	7
Catfish	112
Clams, Pismo	693
Cockles	750
Lobsters	591
Lobster traps	13
Oysters, pounds	400
Salmon	423
Sunfish	10
Game:	
Coot	1
Curlew	1
Deer	4
Deer hides	2
Deer meat, pounds	2,894
Doves	189
Dowitchers	3
Ducks	626
Ducks, mallard	20
Ducks, sprig	61
Ducks, wood	22
Geese	56
Grebe	2
Lark	1
Mocking bird	1
Muskrats	6
Muskrat pelts	38
Pheasants	95
Pigeon	10
Phalaropes	2
Quail, valley	7
Quail, desert	18
Rabbits	9
Sandhill crane	1
Sandpipers	9
Swan	3
Tree squirrels	4
Willets	4
Yellowlegs	3

FISH CASES

October, November, December, 1940

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones: possession undersized, overlimit	26	$804 50	4
Angling: transferring license, no license, at night, fail to show license, closed season, closed area	52	747 50	192½
Barracuda: no license	1	10 00	
Bass, striped: no license, undersized, at night, with nets	91	1,682 50	445
Catfish: undersized, overlimit	5	1,021 00	187
Clams: undersized Pismo, no license; cockles, no license	34	692 50	57
Commercial fishing: no license	71	985 00	256½
Crabs: closed season	2	85 00	
Croaker, spotfin: no license	1	5 00	
Explosives: use to take fish	2		
Fail to keep catch records, receipts	3	100 00	
Fishing from dam	2	50 00	
Fyke nets	5	200 00	
Gill net with meshes over 1¾ inch in length	1		50
Lobsters: undersized, closed season	16	190 00	50
Oysters: take from beds without permission	2	75 00	
Pollution	15	2,850 00	
Purse seine net in District 118.5	10	1,050 00	
Salmon: gill net, overlimit, no license, spear, take with rifle	100	2,240 00	124½
Spear within 300 ft. of stream, at Woodbridge Dam	13	90 00	40
Sunfish: no license	2	20 00	
Trout: take from rearing ponds, overlimit, more than 1 rod and line	7	105 00	10
Totals	461	$13,003 00	1,416½

GAME CASES

October, November, December, 1940

Offense	Number arrests	Fines imposed	Jail sentences (days)
Bear: closed season	1	$25 00	
Beaver: possession	1		
Brant, black	5	125 00	
Coots: shoot from motorboat, after 4 p.m.	2	35 00	
Curlew: closed season, no license	3	70 00	
Deer: possess spike buck, possess in refuge, kill female deer, closed season, possess fawn, no license, fail to retain hide and horns, spotlighting, transporting deer meat, no permit, venison, closed season	120	5,890 00	1,581½
Deer tags: fail to validate, no deer tags, not properly filled out, fail to have countersigned, defacing deer tag	47	1,175 50	95
Doves: overlimit, no license, trapping doves	16	275 00	
Ducks: closed season, no license, before sunrise, possess wood ducks, shoot from power boat	149	5,837 50	50
Firearms in refuge	32	502 50	
Game birds: shoot from power boat, rail, sandpiper, no license	12	255 00	
Geese: closed season, shoot from auto, overlimit	35	805 00	
Grouse	2	35 00	
Hunting: no license, night, using another's license, in refuge, from auto, fail show license on demand, on posted land, closed area	81	1,550 00	22
Muskrats: closed season	2	50 00	
Non-game birds	12	225 00	
Pheasants: closed season, hen pheasant	118	3,338 00	43½
Pigeon: closed season	3	125 00	
Quail: closed season, no license	30	470 00	30
Rabbits: no license, closed season, cottontail and jack rabbits	9	123 00	12½
Shoot from road, from auto, early, late, no gun plug, at night, in State Park, in refuge	35	510 00	12½
Shorebirds	17	365 00	
Sparrows	1	10 00	
Squirrel: tree	2		25
Swan: possession, shooting	2	25 00	
Trap: interfere with trapper, on refuge, no permit	4	60 00	
Waterfowl: shooting before sunrise	87	1,570 00	
Totals	828	$23,451 50	1,872

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS, OCTOBER, 1940

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Waters south international boundary		
	*Del Norte and Eureka Region	Sacramento Region	San Francisco Region	Monterey Region	Santa Barbara Region	Los Angeles Region	San Diego Region	Total pounds	Los Angeles Region	San Diego Region	Total landings by fishing boats
Anchovy						1,489,337		1,489,337			1,489,337
Barracuda					13,020	13,724	7,067	33,811	259,716	11,868	305,395
Cabezone			55	16		53		124			124
Carp		386						386			386
Catfish		14,763						14,763			14,763
Cultus, Pacific	25,700		35,652	6,340	143	25		67,860			67,860
Eel			7					7			7
Flounder, Starry	5,740		87,018	33	35			92,826			92,826
Flying Fish						75		75			75
Grouper									50		50
Hake	300		1,527					1,827			1,827
Halibut, California			1,943	1,588	33,096	4,318	2,139	43,084		6,049	49,133
Halibut, Northern	1		339					340			340
Kingfish			274	8,556		22,720	282	31,832			31,832
Mackerel, Horse				5,257		393,273		398,530			398,530
Mackerel, Pacific				50,122	26,513	33,076,080	11,620	33,164,335			33,164,335
Mackerel, Spanish									441		441
Perch			1,090		24	301		1,415			1,415
Pike		30						30			30
Pompano, California						3,099		3,099			3,099
Rock Bass					1,978	2,166	4,355	8,499		545	9,044
Rockfish	53,878		44,961	105,432	15,987	18,797	4,683	243,738		3,697	247,435
Sablefish	33,869		20,943	15,101		453		70,366			70,366
Sand Dab	42,005		23,671	4,851	8	1,085		71,620			71,620
Sardine		20,470,100	63,985,291	112,005,580		1,014,446	289	197,475,706			197,475,706
Sculpin					24	5,542	2,035	7,601			7,601
Sea-bass, Black					925	250		1,175	48,925	2,503	52,603
Sea-bass, White			9,119	8,542	11,944	3,699	2,500	35,804	1,682	12,060	49,546
Shark	136,953		586,478	58,101	11,682	8,179	401	801,794	112		801,906
Sheepshead					199	2,508	1,083	3,790		861	4,651
Skate	2,190		10,771	592	2,300	285		16,138			16,138
Smelt	7,693		6,902	19,034	259	20,874	4,086	58,848			58,848
Sole	483,890		226,950	1,094	4,706	383		717,023			717,023
Split-tail		4,172						4,172			4,172
Swordfish, Broadbill					52,110	52,357	1,726	106,193			106,193
Tuna, Albacore			6,384	40,914	37,977	1,871		87,146			87,146
Tuna, Bluefin						53,728	153	53,881	43,604		97,485
Tuna, Bonito				11	1,564	365,583	381	367,539	224,260	55,715	647,514
Tuna, Skipjack					18	322,059	1,255,516	1,577,593	1,381,098	5,157,163	8,115,854

Tuna, Yellowfin						11,252	49,162	60,414	1,443,773	8,295,032	9,799,219
Turbot			4,084					4,084			4,084
Whitebait	635		229					864			864
Whitefish, Ocean					261	592		853		1,184	2,037
Yellowtail					185	570	1,502	2,257	45,428	144,959	192,644
Miscellaneous Fish	14,062		5,940	14	521	4,838		25,375	32		25,407
Crustacean:											
Crab			2,472					2,472			2,472
Crab, Rock						492		492			492
Lobster, Spiny					42,711	53,367	34,175	130,253		275	130,528
Shrimp			63,039	63				63,102			63,102
Mollusk:											
Abalone				6,975	106,600	75		113,650			113,650
Clam, Cockle			32			216		248			248
Clam, Gaper			140					140			140
Clam, Pismo				1,483	11,695			13,178			13,178
Clam, Soft-shell	12		7,871					7,883			7,883
Clam, Washington	3,290		64					3,354			3,354
Octopus	404		386	637		76		1,503			1,503
Oyster, Eastern			10,842		2			10,844			10,844
Oyster, Japanese			153,225		19,509			172,734			172,734
Oyster, Native			1,476					1,476			1,476
Snail						125		125			125
Squid				14,855		4,645		19,500			19,500
Total pounds	810,622	20,489,451	65,299,175	112,355,191	395,996	36,953,518	1,383,155	237,687,108	3,449,121	13,691,911	254,828,140

* The geographical regions of the State are as follows:
Del Norte and Eureka Region: Del Norte, Humboldt and Mendocino counties.
Sacramento Region: Sacramento and San Joaquin River systems with the delta areas, including Suisun Bay and Lake County.
San Francisco Region: Sonoma, Marin, San Francisco and San Mateo counties, including San Francisco and San Pablo bays.
Monterey Region: Santa Cruz and Monterey counties.
Santa Barbara Region: San Luis Obispo, Santa Barbara and Ventura counties.
Los Angeles Region: Los Angeles and Orange counties.
San Diego Region: San Diego and Imperial counties.
These tables are subject to slight revision due to belated supplemental items

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS, NOVEMBER, 1940

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Waters south international boundary		
	*Del Norte and Eureka Region	Sacramento Region	San Francisco Region	Monterey Region	Santa Barbara Region	Los Angeles Region	San Diego Region	Total pounds	Los Angeles Region	San Diego Region	Total landings by fishing boats
Anchovy				25,575		1,588,461		1,614,036			1,614,036
Barracuda					31,664	3,733	4,883	40,280	200,949	3,576	244,805
Cabezone	67		100	33	174			374			374
Carp		623						623			623
Catfish		18,515						18,515			18,515
Cultus, Pacific	85,916		66,791	17,223	249	140		170,319			170,319
Flounder, Starry	8,725		41,200	260				50,185			50,185
Hake			575					575			575
Halibut, California			6,766	727	18,624	6,630	16,018	48,765			48,765
Halibut, Northern	53							53			53
Hardhead		716						716			716
Herring, Pacific			300				714	1,014			1,014
Kingfish			1,004	14,962		16,719	122	32,807			32,807
Mackerel, Horse				5,275		188,061		193,336			193,336
Mackerel, Pacific				18,620	52,587	27,317,447	189,843	27,578,497			27,578,497
Mackerel, Spanish									497		497
Perch			337	9		740		1,086			1,086
Pike		55						55			55
Pompano, California						275		275			275
Rock Bass					4,811	3,688	3,961	12,460	75		12,535
Rockfish	80,054		37,911	117,209	41,569	31,702	8,670	317,115		9,686	326,801
Sablefish	6,444		15,902	22,509		504		45,359			45,359
Salmon		605						605			605
Sand Dab	29,113		21,564	2,812		1,644		55,133			55,133
Sardine		23,556,500	63,384,330	82,647,947	27,920	133,409,932	425,199	303,451,828			303,451,828
Sculpin						5,837	9,801	15,638			15,638
Sea-bass, Black					617	754		1,371	18,385	140	19,896
Sea-bass, White			3,321	625	5,788	2,350	571	12,655	4,698	125	17,478
Shark	155,232		588,086	79,753	5,432	12,725	1,419	842,647			842,647
Sheepshead					1,755	1,276	450	3,481		852	4,333
Skate	639		8,878	39	1,444	326		11,326			11,326
Smelt	683		8,726	12,288	77	15,834	1,927	39,535			39,535
Sole	406,490		197,788	228	4,179	473	26	609,184			609,184
Split-tail		2,744						2,744			2,744
Swordfish, Broadbill					9,582	2,300		11,882			11,882
Tomcod	1,215		186					1,401			1,401
Tuna, Albacore			16		148	11,146		11,310			11,310
Tuna, Bluefin						15		15		194	209
Tuna, Bonito					9,920	18,212	660	28,792	7,529	50,244	86,565

Tuna, Skipjack						181,493	208,147	389,640	894,753	4,684,378	5,968,771
Tuna, Yellowfin						6,068	5,627	11,695	1,072,595	7,678,023	8,762,313
Turbot			1,737		3			1,740			1,740
Whitebait			50					50			50
Whitefish, Ocean					5,496	730	125	6,351		3,189	9,540
Yellowtail						30	422	452	27,490	305,527	333,469
Miscellaneous Fish	10,935		5,762		2,410	1,377		20,484	6		20,490
Crustacean:											
Crab											
Crab, Rock			681,012	1,822				682,834			682,834
Lobster, Spiny						308		308			308
Shrimp			76,503	1,038	19,227	38,606	11,235	69,068	1,157	120,499	190,724
								77,541			77,541
Mollusk:											
Abalone				28,425	149,729			178,154			178,154
Clam, Cockle			44					44			44
Clam, Gaper			200					200			200
Clam, Pismo				3,237	10,877			14,114			14,114
Clam, Soft-shell	12		8,452					8,464			8,464
Clam, Washington	2,628		104					2,732			2,732
Octopus	1,183		957	461		214		2,815			2,815
Oyster, Eastern			12,251					12,251			12,251
Oyster, Japanese			137,086		17,335			154,421			154,421
Oyster, Native			167					167			167
Squid				11,555			26,642	38,197			38,197
Total pounds	789,389	23,579,758	65,308,106	83,012,632	421,617	162,869,750	916,462	336,897,714	2,228,134	12,856,433	351,982,281

* See footnote to table for October.

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS, DECEMBER, 1940

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Oregon and Washington waters	Waters south international boundary		Total landings by fishing boats
	*Del Norte and Eureka Region	Sacramento Region	San Francisco Region	Monterey Region	Santa Barbara Region	Los Angeles Region	San Diego Region	Total pounds	Del Norte and Eureka Region	Los Angeles Region	San Diego Region	
Anchovy						630,521	14,755	645,276				645,276
Barracuda					4,659	11,403	1,689	17,751		146,403	15,650	179,804
Cabezone			117					117				117
Carp		275						275				275
Catfish		17,701						17,701				17,701
Cultus, Pacific	22,073		31,275	10,003	163	26	28	63,568	100		213	63,881
Flounder, Starry	1,330		14,832	8				16,170				16,170
Halibut, California			3,688	2,281	18,593	11,537	1,531	37,630			4,971	42,601
Hardhead		4,144						4,144				4,144
Herring, Pacific			16,630				1,195	17,825				17,825
Kingfish			457	8,865		12,146	99	21,567				21,567
Mackerel, Horse				6,338		47,352		53,690				53,690
Mackerel, Pacific				9,727	246,789	13,483,519	268,029	14,008,064				14,008,064
Mackerel, Spanish											85	85
Perch			622	8		800		1,430				1,430
Pompano, California						220		220				220
Rock Bass					5,343	2,836	2,376	10,555			87	10,642
Rockfish	22,590		31,743	76,545	10,272	62,792	4,212	208,154	200		11,767	220,121
Sablefish	3,185		1,092	9,257		664		14,198				14,198
Salmon		208						208				208
Sand Dab	8,060		22,650	215	47	1,216	35	32,223	130			32,353
Sardine		9,135,600	23,347,270	71,644,386	22,600	74,396,351	1,654,569	180,200,776				180,200,776
Sculpin					2	1,545	2,500	4,047				4,047
Sea-bass, Black				298	588	376		1,262		108	9,271	10,641
Sea-bass, White			2,005	332	6,210	4,302	15,364	28,213		670	16,557	45,440
Shark	118,975		464,591	154,177	8,188	6,421	1,351	753,703			550	754,253
Sheepshead					525	911	839	2,275			2,033	4,308
Skate	1,165		21,987	501	2,320	219	22	26,214				26,214
Smelt	107		3,901	9,979	62	17,416	1,801	33,266				33,266
Sole	147,627		237,341	43	5,152	293		390,456	2,470			392,926
Split-tail		1,061						1,061				1,061
Sucker		5						5				5
Tomcod	371		30					401				401
Tuna, Bluefin											463	463
Tuna, Bonito				33	3,564	3,827	1,265	8,689		3,765	192,492	204,946
Tuna, Skipjack										951,047	3,082,622	4,033,669

Tuna, Yellowfin									1,247,873	7,199,736		8,447,609
Turbot			1,848					1,848				1,848
Whitebait	27		1,205	57				1,289				1,289
Whitefish, Ocean					2,935	564	815	4,314		2,394		6,708
Yellowtail						2,280	87	2,367	11,997	403,678		418,042
Miscellaneous Fish	5,380		4,562		673	470		11,085				11,085
Crustacean:												
Crab	13,826		415,376	2,642				431,844				431,844
Crab, Rock						94		94				94
Lobster, Spiny					17,435	21,938	6,477	45,850	6,244	152,462		204,556
Shrimp			39,540	484				40,024				40,024
Mollusk:												
Abalone				12,500	59,405			71,905				71,905
Clam, Cockle			32			14		46				46
Clam, Gaper			20					20				20
Clam, Pismo				2,375	6,582			8,957				8,957
Clam, Soft-shell			4,851					4,851				4,851
Clam, Washington	2,237		16					2,253				2,253
Octopus	344		414	549		95		1,402				1,402
Oyster, Eastern			14,867					14,867				14,867
Oyster, Japanese			142,261		17,719			159,980				159,980
Snail			100					100				100
Squid				8,897		28,620	6,068	43,585				43,585
Total pounds	347,297	9,158,994	24,825,323	71,960,500	439,826	88,750,768	1,985,107	197,467,815	2,900	2,368,107	11,095,031	210,933,853

* See footnote to table for October.

SHIPMENTS OF FRESH FISH FROM OTHER STATES AND FOREIGN COUNTRIES

October, 1940

	Oregon and Washington	South of international boundary	Japan
For canneries:			
Tuna, Albacore	52,695		
For fresh fish markets:*			
Barracuda		6,800	
Crustacean:			
Shrimp		21,072	
Total pounds	52,695	27,872	

November, 1940

	Oregon and Washington	South of international boundary	Japan
For canneries:			
Tuna, Albacore	48,560		
For fresh fish markets:*			
Cabrilla		509	
Corbina, Mexican		432	
Grouper		312	
Sea-bass, Totuava		39,140	
Crustacean:			
Shrimp		7,143	
Mollusk:			
Clam, unclassified		150	
Total pounds	48,560	47,686	

December, 1940

	Oregon and Washington	South of international boundary	Japan
For canneries:			
Tuna, Albacore			77,866
For fresh fish markets:*			
Cabrilla		1,019	
Perch		262	
Rockfish		820	
Sea-bass, Black		78	
Sea-bass, Totuava		103,308	
Smelt		225	
Crustacean:			
Shrimp		3,815	
Total pounds		109,527	77,866

* This record includes only that fish which is voluntarily reported to the Division of Fish and Game and does not represent all shipments.

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BUREAU OF ENGINEERING

JOHN SPENCER, Chief---San Francisco
Clarence Elliger, Assistant Hydraulic Engineer---San Francisco
Byron Wittorff, Assistant---Red Bluff
Samuel Kabakov, Civil Engineering Draftsman---San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief---Sacramento
L. O'Leary, Supervising License Agent---Sacramento
Emil Dorig, License Agent---San Francisco
R. Nickerson, Supervising License Agent---Los Angeles

ACCOUNTS AND DISBURSEMENTS

D. H. BLOOD, Departmental Accounting Officer---Sacramento

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol (absent on military leave)---San Francisco

L. F. CHAPPELL, Chief of Patrol---San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

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Northern Division

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Jos. H. Sanders, Captain---Sacramento
A. H. Willard, Captain---Nevada City
E. O. Wraith, Captain---Susanville
L. E. Mercer, Warden, Butte County---Chico
Chester Ramsey, Warden, Butte County---Oroville
Taylor London, Warden, Colusa County---Colusa
Albert Sears, Warden, El Dorado County---Placerville
E. C. Vail, Warden, Glenn County---Willows
Jack Sawyer, Warden, Lassen County---Westwood
Don Davison, Warden, Modoc County---Alturas
Earl Hiscox, Warden, Nevada County---Nevada City
Wm. La Marr, Warden, Placer County---Tahoe City
Nelson Poole, Warden, Placer County---Auburn
E. J. Johnson, Warden, Plumas County---Quincy
George Shockley, Warden, Plumas County---Portola
H. S. Vary, Warden, Sacramento County---Sacramento
Eugene Durney, Warden, Sacramento County---Sacramento
Earl Caldwell, Warden, Shasta County---Burney
Chas. Love, Warden, Shasta County---Redding
Don Chipman, Warden, Siskiyou County---Dunsmuir
Brice Hammack, Warden, Siskiyou County---Yreka
Lewis Olive, Warden, Siskiyou County---Tule Lake
Fred R. Starr, Warden, Siskiyou County---Dorris
R. E. Tutt, Warden, Sierra County---Downieville
J. E. Hughes, Warden, Solano County---Dixon
A. Granstrom, Warden, Sutter County---Yuba City
R. W. Anderson, Warden, Tehama County---Red Bluff
Harold Erwick, Warden, Tehama County---Corning
C. L. Gourley, Warden, Trinity County---Weaverville
C. O. Fisher, Warden, Yolo County---Woodland
R. A. Tinnin, Warden, Yuba County---Browns Valley

Southern Division

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John O'Connell, Captain---Stockton
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Lester Arnold, Warden, Kern County---Bakersfield
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Gilbert T. Davis, Warden, Mariposa County---Mariposa
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